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**Department of Physics**

**College of Science**

**University of Salahaddin**

**Subject: Solid State Physics (I)**

**Course Book – (Year 3rd and 4th – Medical Physics)**

**Lecturer's name *Asst. Prof. Dr Hawkar Taher Taha***

**Academic Year: 2022-2023**

**Course Book**

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| **1. Course name** | **Solid State Physics (I)** | |
| **2. Lecturer in charge** | **Asst. Prof. Dr. Hawkar Taher Taha** | |
| **3. Department/ College** |  | |
| **4. Contact** | **e-mail: hawker.taha@su.edu.krd**  **Tel:** | |
| **5. Time (in hours) per week** | **Theory: 3**  **Practical: 0** | |
| **6. Office hours** | **4** | |
| **7. Course code** |  | |
| **8. Teacher's academic profile** | **I have more than 23 year experience teaching of different subjects such as: Properties of Matter, General Physics, Linear Algebra, Optics, Nanotechnology, Solid State Physics and Quantum Mechanics also I have four(4) papers are published in different foreign journals. Supervising M.Sc. student during my duty in the college. Participation in different conferences and meeting over the world. I worked in e-learning filed too, up to date I am member in Abn Sinna Center for e-learning which supporting form UNESCO.**  **B.Sc. of Physics from 1992**  **M.Sc. of Solid State Physics from 1996**  **Ph. D of Nanotechnology from 2008**  **Assist Lecturer** Oct 1996 – March 2008  **Instructor** Feb 2008 – up to date  **Assist Prof.** …………. | |
| **9. Keywords** | **Solid State Physics, Condensed Matter Physics, Applied Solid State Physics** | |
| **10. Course overview:**  This course is intended for students enrolling for BSc degrees. Solid state physics forms the backborn of physics. The module has four units: Introduction to solid state physics; Crystal defects and mechanical properties ; Thermal and electrical properties; and Band theory & Optical properties.  In the first unit/activity i.e. introduction to solid state physics. The student is expected to explain the atomic structure, describe the various atomic bonds such as ionic bonds and covalent bonds. The learning will also require students to distinguish between crystalline and amorphous solids; polycrystalline and amorphous solids and to explain the production and use of X-ray diffraction. And also the mechanical properties of solids will be studied including lattice vibration for the two systems of monatomic and diatomic, from the two we understand how the energy will interact with mater. From this low energy and high energy interaction will be understand throughout the 1st BZ diagram. In this case the dispersion curve in 1st BZ is one of the most important subjects to be understood. The Debye and Einstein model for lattice thermal properties also one of the important subject will be in the lecturer text  In the second unit i.e. crystal defects and mechanical properties, the learning includes, differentiating between the different types of crystal defects: the point defects (vacancy, interstitials, and substitutional) and dislocations (screw and edge). Here, the student learns that point defects are very localised and are of atomic size, while dislocation is a disorder which extend beyond the volume of one or two atoms. The effects of the defects on mechanical, and electrical properties of these defects are also part of the learning that will take place.  In unit three the learning outcomes include definitions of heat capacity, and explanations of variation of heat capacity with temperature based on the classical, Einstein and Debye models. The students will be required to use the free electron theory to explain high thermal and electrical conductivities of metals and also be able to derive and apply the Wiedermann-Frantz law.  Finally, in activity four, the expected learning should enable the students to use the band theory to explain the differences between conductors, semiconductors and insulators; explain the differences between intrinsic and extrinsic semiconductors in relation to the role of doping. At the end of it all, the students use the concepts of the interaction of electromagnetic waves (light) with materials to explain optical absorption, reflectivity and transmissivity. | | |
| **11. Course objective:**  Solid State Physics is one of the subjects which serves students in Physics, Inorganic chemistry, Materials Science, Mechanical Engineering and electronic engineering for understanding the formation and electronic properties of solid materials. In Medical Physics people needs to understand how solid materials can be used to detect radiation signals such as X-ray, Gamma ray and cosmic ray. Understanding Solid State will also help to understand how instruments such as CT scan, MR imaging, digital camera, photo detectors and many other similar instruments are working. The information will also give abilities to people to improve their mind to understand and build new instruments. | | |
| **12. Student's obligation**         Students are expected to develop a clear concept of the crystal classes and symmetries and to understand the relationship between the real and reciprocal space.         Students will be able to calculate the Braggs conditions for X-ray diffraction in crystals and will calculate the conditions for allowed and forbidden reflections in crystals         Students will learn the basics of the optical and acoustic phonons in crystals         Students will become familiar with the free-electron model for metals and use the concept of Fermi energy and Fermi temperature.         Basic concepts of the band theory of solids will be given to Students, who will be able to predict the optical properties of materials and compounds         Students will learn the basic properties of superconductors in the frame of BCS theory         Students will master their skills for oral presentations on the selected topics of the modern Solid State Theory.  Understanding of these major concepts of the Solid State Theory will be tested at the two Common Quizzes and the Final Exam. | | |
| **13. Forms of teaching**  Our lecture is depend directly on showing the strong point in the lecture via data show depending on the power point program… and solve problem on the white board with the students.  لێره‌ مامۆستا ڕێگه‌ی وانه‌‌ ووتنه‌وه‌ ده‌نووسێت، بۆ نموونه‌:‌ داتاشۆ و پاوه‌رپۆینت، ‌سه‌ر ته‌خته‌ڕه‌ش، ته‌خته‌ی سپی، سمارتبۆرد یان‌ مه‌لزه‌مه‌... هتد | | |
| **14. Assessment scheme**  All exams have 30 marks, full report has 5 marks, the classroom activities count and for attendance 5 Marks. So that the final grade will be based upon the following criteria:  Mid- semester exam: 30%  Classroom participation and assignments: 5%  Report: 5%  Final Exam: 60% .  Breakdown of overall assessment and examination  لێره‌ مامۆستا جۆری هه‌ڵسه‌نگاندن (تاقیکردنه‌وه‌کان یان ئه‌زموونه‌کان) ده‌نووسێت بۆ نموونه‌ تاقیکردنه‌وه‌ی مانگانه‌، کویزه‌کان، بیرکردنه‌وه‌ی ڕه‌خنه‌گرانه (پریزه‌نته‌یشن)، ڕاپۆرت نووسین، ووتار نووسین‌ یان ئاماده‌نه‌بوونی خوێندکار له‌ پۆلدا...هتد. ئامانه‌ چه‌ند نمره‌ی له‌سه‌رده‌بێت و مامۆستا چۆن نمره‌کان دابه‌شده‌کات؟‌ | | |
| **15. Student learning outcome:**  Solid State Physics make students to understand how condensed matter; behave in their thermal and electrical properties. Help the students after graduation to get work in areas of electronics and devices as well as places regarding X-ray images and CT-can centres since a part of the solid state physics subject, they have to study the X-ray crystallography and the formation of matter | | |
| **16. Course Reading List and References‌:**  **Books**: *There are many good introductory texts on Solid State Physics, for example:*  (i) Introduction to solid state physics - Charles Kittel  (ii) Solid State Physics - A. J. Dekker  (iii) Solid State Physics ( Problems and solutions) - S. O. Pillai  (iv) Solid State Physics - S. O. Pillai  (v) Solid State Physics - S.P.Kakani and AmitKakani  ▪Magazines and review (internet): | | |
| **17. The Topics:** | | **Lecturer's name** |
| **(15 lectures) Crystal physics:** Introduction, lattice, basis, crystal structure, unit cell & primitive cell, crystal classes & crystal systems in two & three dimensions, Bravais lattices, atomic packing factors in cubic system and hexagonal lattice. Crystal structures of diamond, ZnS, Nacl, CsCl, Miller indices, Inter-planar spacing. Experimental diffraction methods, derivation of scattered wave amplitude, Brillouin zones , Fourier analysis of the basis. Ch.1, 2 - Kittle 5thed | | D. Hawkar Taher Taha  ex: (3 hrs)  ex: 1 – 5 Weeks |
| **II (15 lectures) Theory of metals :** Sound Waves, Lattice Vibrations of 1D Crystals, chain of identical atoms, chain of two types of atoms, Lattice Vibrations of 3D Crystals, PHONONS, Heat Capacity from lattice Vibration, Anharmonic Effects Thermal Conductivity, Thermal Expansion By Phonons, Classical free electron theory of metals, Relaxation time, Collision time and mean free path, Drawbacks of classical theory, Quantum theory of free electrons, Fermi-Dirac statistics and electronic distribution in solids, Density of energy states and Fermi energy, The Fermi distribution function, Heat capacity of the electron gas, Mean energy of electron gas at 0K, Effect of temperature on Fermi distribution function, Electrical conductivity from quantum mechanical considerations, Hall effect.Ch. 6– Kittle | | D. Hawkar Taher Taha  ex: (3 hrs)  ex: 6-10 Weeks |
| **First Examination** | |  |
| **UNIT - III (15 lectures) 1. Band theory of solids:** The Kronig- Penney model Brillouin zones, Number of wave functions in a band, Motion of electrons in a one-dimensional periodic potential, Distinction between metals, insulators and intrinsic semiconductors. **2. Band theory of Semiconductors:** Electrons and Holes in an Intrinsic Semiconductor, Conductivity, Carrier concentrations, Donor and Acceptor impurities, Charge densities in a Semiconductor, Fermi level in extrinsic semiconductors, Diffusion, Carrier lifetime, The continuity equation. Ch. 7, 8 – Kittle | | D. Hawkar Taher Taha  ex: (3 hrs)  ex: 11-15 Weeks |
| **18. Practical Topics (If there is any)** | |  |
| In this section The lecturer shall write titles of all practical topics he/she is going to give during the term. This also includes a brief description of the objectives of each topic, date and time of the lecture | |  |
| **19. Examinations:**   |  |  |  | | --- | --- | --- | | **University of Salahaddin-Erbil**  **College of Science**  **Physics Department** |  | **Subj.: *Solid State Physics***  **Time: 90 mint.**  **Date: / / 20** |   **Q.1\ Explain the dispersion relation. Derive the dispersion relation for monatomic lattice, then explain it at low and high frequency?**  **Q.2\** **Define the Miller indices, In cubic unit cell draw plane for coordinate [1/2,1/4,0] and [1,1,1/2], and then find the angle between them.**  **Q.3\ Draw the dispersion curve for the diatomic lattices when M the small atom while m the large atom, then explain dispersion curve for**  **1-**  **2-**  **3- (∞)**  **Q.4\ Draw the Bravais lattice for a=b=c, and α=β=90o≠γ, then named the Bravais lattice.**  **Q.5\ Depending on Von Laue Condition, derive the Bragg's Equation.**  **Q.6\ Find the atomic packing factor for BCC unit cell of Cu, if you know that the nearest neighbor distance is 1.805Ao.**  **Q.7\ Draw a two dimensional real space lattices with a primitive vector of a=b, the draw a reciprocal lattice point, then show the reciprocal lattice points [020], [210] and[130].**  **Q.8\ What is the Miller index of the plane below?**  **Description: C:\Teaching\Physics\hkl.gif**  **Description: C:\Teaching\Physics\hklex.gif** | | |
| **20. Extra notes:**  Here the lecturer shall write any note or comment that is not covered in this template and he/she wishes to enrich the course book with his/her valuable remarks. | | |
| **21. Peer review پێداچوونه‌وه‌ی هاوه‌ڵ**  This course book has to be reviewed and signed by a peer. The peer approves the contents of your course book by writing few sentences in this section.  *(A peer is person who has enough knowledge about the subject you are teaching, he/she has to be a professor, assistant professor, a lecturer or an expert in the field of your subject).*  ئه‌م کۆرسبووکه‌ ده‌بێت له‌لایه‌ن هاوه‌ڵێکی ئه‌کادیمیه‌وه‌ سه‌یر بکرێت و ناوه‌ڕۆکی بابه‌ته‌کانی کۆرسه‌که‌ په‌سه‌ند بکات و جه‌ند ووشه‌یه‌ک بنووسێت له‌سه‌ر شیاوی ناوه‌ڕۆکی کۆرسه‌که و واژووی له‌سه‌ر بکات.  هاوه‌ڵ ئه‌و که‌سه‌یه‌ که‌ زانیاری هه‌بێت له‌سه‌ر کۆرسه‌که‌ و ده‌بیت پله‌ی زانستی له‌ مامۆستا که‌متر نه‌بێت.‌‌ | | |