**University of Management and Technology**

**School of Science and Technology**

***Department of Physics***

**Course Code:** **PH 7263**

**Course Title: Solid State Physics**

**Program: MS (Phy)**

**Course Outline**

**Course Description**

Basic assumption of the Drude model, Collision or relaxation times, DC Electrical conductivity, Hall Effect and Magnetoresistance, Thermal Conductivity and Thermoelectric effect, Fermi-Dirac Distribution, Free electrons, Density of allowed Wave Vectors, Fermi Momentum, Energy and Temperature, The Sommerfeld theory of Conduction in Metals, Difficulties with the free electron model, Bravais Lattice and Primitive Vectors, Simple, Body-Centerd and Face-Centred Cubic Lattices, Primitive Unit Cell, Wigner-Seitz Cell, and Conventional Cell, Crystal Structures and Lattices with Bases, Hexagonal Close-Packed and Dimond Structures, Sodium Chloride, Cesium Chloride, and Znicblende Structure, Definition of Reciprocal lattice and examples, First Brillouin Zone, Lattice Planes and Miller Indices, Formulation of Bragg and Von Laue, The Laue Condition and Ewald’s Construction, Experimental Methods: Laue, Rotating crystal, Powder, Geometrical Structure factor, Atomic Form Factor, Symmetry operations and the classification of Bravais Lattice, Seven Crystal system and fourteen Bravais Lattices, Examples among the elements, The periodic potential and Bloch’s Theorem, Born-Von Karman Boundary Condition, Crystal Momentum, Band Index, and Velocity, The Fermi Surface, Density of levels and Van Hove Singularities, Perturbation theory and Weak periodic potentials, Energy levels near a single Bragg planes, Illustration of extended, reduced and repeated Zone schemes in one dimension. Fermi Surface and Brillouin Zones, Alkali Metals, Nobel Metals, Divalent Simple Metals, Trivalent Simple Metals, Tetravalent Simple Metals, Semimetals, Transition Metals, Alloys, The work function, Contact potentials, Thermionic Emission, The spatial distribution of valence Electrons, Covalent, Molecular, Ionic Crystals, the Alkali Halides, Ionic Radii, II-VI and III-V Compounds, Covalent Crystals, Molecular Crystals, Metals, Hydrogen Bounded Solids, The Lennerd-Jones Potential, The Madelung Constant, Cohesion in Covalent Crystals, Cohesion in Metals, Specific heat of a classical Crystal, One, Dimensional Lattice with a Basis, Three Dimensional Lattice with a Basis, Normal Modes and Phonons, High temperature Specific Heat, Low Temperature Specific Heat, Models of Debye and Einstein.

Expected Outcomes: Participants will become familiar with the physics of solids and the role of electrons, phonons and their interactions in determining the thermal, mechanical, electrical, magnetic, and optical properties of materials.

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| **Schedule** | Tuesday (18:30-21:30) | **Pre-requisite** | Electricity and Magnetism and Quantum Mechanics (BS Level), Thermal and statistical Physics | |
| **Course Coordinator** | Dr. Tanvir Hussain | **Contact** | tanvir.hussain@umt.edu.pk | |
| **Text**  **Book** | Solid State Physics by Ashcroft and Mermin. | | | |
| **Reference Book:** | 1. The Oxford Solid State Basics by Simon 2. Introduction to Solid State Physics by Kittle ( 8th Edition) | | | |
| **Assignments** | Problems will be assigned at regular intervals as an assignment. | **Quizzes** | | All quizzes will be announced well before time.  No make-ups will be offered for missed quizzes. |
| **Mid Term**  **Examination** | A 60-minutes exam will cover all the material covered during the first  14-16 lectures.  Combined Mid Term exam for all multiple sections. | **Final**  **Examination** | | A 120-minutes exam will cover all the material covered during the semester.  Combined Final exam for all multiple sections |
| **Attendance**  **Policy** | Students missing more than 25% of the lectures will receive an “SA” grade in the course and will not be allowed to take Final exam. | | | |
| **Grading**  **Policy** | Assignment+ Quizzes  (Minimum number of assessments will be 8): 30%  Mid Term Examination: 30%  Final Examination: 40% | | | |

**Department of Physics**

**Statistical Physics(PH 310)**

**Lecture Plan**

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| **Week** | **Lecture**  **#** | **TOPICS** | **CH** | **SECTIONS** |
| 1 | 1 | The Drude theory of metals  Failure of Drude Theory | 1  3 |  |
| 2 | 1 | The Sommerfeld Theory of metals  Failure of Sommerfeld Theory of metals | 2  3 |  |
| 3 | 1 | Crystal lattices | 4 |  |
| 4 | 1 | The reciprocal Lattice | 5 |  |
| 5 | 1 | Determination of crystal structure by X-ray Diffraction | 6 |  |
| 6 | 1 | Classification of Bravais Lattices and Crystal Structure | 7 |  |
| 7 | 1 | Electron levels in periodic potential: General Properties | 8 |  |
| 8 | 1 | Electrons in a weak periodic potential | 9 |  |
| 9 | 1 | Band Structure of the selected metals | 15 |  |
| 10 | 1 | Surface effects | 18 |  |
| 11 | 1 | Classification of Solids | 19 |  |
| 12 | 1 | Cohesive Energy | 20 |  |
| 13 | 1 | Failure of the static lattice model | 21 |  |
| 14 | 1 | Classical theory of the Harmonic Crystal | 22 |  |
| 15 | 1 | Quantum theory of the Harmonic Crystal | 23 |  |

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