

**UNIVERSITY OF MADRAS**  
**M.Sc. DEGREE PROGRAMME IN PHYSICS**  
 SYLLABUS WITH EFFECT FROM 2023-2024

<b>Paper 10 - CONDENSED MATTER PHYSICS</b>	<b>II YEAR - THIRD SEMESTER</b>
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Subject Code	Subject Name	Category	L	T	P	Credits	Inst. Hours	Marks
529C3B	<b>CONDENSED MATTER PHYSICS</b>	Core				4	5	75

<b>Pre-Requisites</b>
Basic knowledge of atomic physics, quantum mechanics and statistical mechanics.
<b>Learning Objectives</b>
<ul style="list-style-type: none"> <li>➤ To describe various crystal structures, symmetry and to differentiate different types of bonding.</li> <li>➤ To construct reciprocal space, understand the lattice dynamics and apply it to concept of specific heat.</li> <li>➤ To critically assess various theories of electrons in solids and their impact in distinguishing solids.</li> <li>➤ Outline different types of magnetic materials and explain the underlying phenomena.</li> <li>➤ Elucidation of concepts of superconductivity, the underlying theories – relate to current areas of research.</li> </ul>

<b>UNITS</b>	<b>Course Details</b>
<b>UNIT I: CRYSTAL PHYSICS</b>	Types of lattices - Miller indices – Symmetry elements and allowed rotations - Simple crystal structures – Atomic Packing Factor- Crystal diffraction - Bragg's law – Scattered Wave Amplitude - Reciprocal Lattice (sc, bcc, fcc). Structure and properties of liquid crystals. Diffraction Conditions - Laue equations - Brillouin zone - Structure factor - Atomic form factor - Inert gas crystals - Cohesive energy of ionic crystals - Madelung constant - Types of crystal binding (general ideas).
<b>UNIT II: LATTICE DYNAMICS</b>	Lattice with two atoms per primitive cell - First Brillouin zone - Group and phase velocities - Quantization of lattice vibrations - Phonon momentum - Inelastic scattering by phonons - Debye's theory of lattice heat capacity - Thermal Conductivity - Umklapp processes.
<b>UNIT III: THEORY OF METALS AND SEMICONDUCTORS</b>	Free electron gas in three dimensions - Electronic heat capacity - Wiedemann-Franz law - Band theory of metals and semiconductors - Bloch theorem - Kronig-Penney model - Semiconductors - Intrinsic carrier concentration – Temperature Dependence - Mobility - Impurity conductivity – Impurity states - Hall effect - Fermi surfaces and construction - Experimental methods in Fermi surface studies - de Hass-van Alphen effect .

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<b>UNIT IV: MAGNETISM</b>	Diamagnetism - Quantum theory of paramagnetism - Rare earth ion - Hund's rule - Quenching of orbital angular momentum - Adiabatic demagnetization - Quantum theory of ferromagnetism - Curie point - Exchange integral - Heisenberg's interpretation of Weiss field - Ferromagnetic domains - Bloch wall - Spin waves - Quantization - Magnons - Thermal excitation of magnons - Curie temperature and susceptibility of ferrimagnets - Theory of antiferromagnetism - Neel temperature.
<b>UNIT V: Superconductivity</b>	<b>Experimental facts:</b> Occurrence - Effect of magnetic fields - Meissner effect - Critical field - Critical current - Entropy and heat capacity - Energy gap - Microwave and infrared properties - Type I and II Superconductors. <b>Theoretical Explanation:</b> Thermodynamics of super conducting transition - London equation - Coherence length - Isotope effect - Cooper pairs - Bardeen Cooper Schrieffer (BCS) Theory - BCS to Bose - Einstein Condensation (BEC) regime- Nature of pairing and condensation of Fermions. Single particle tunneling - Josephson tunneling - DC and AC Josephson effects - High temperature Superconductors - SQUIDS.
<b>UNIT VI: PROFESSIONAL COMPONENTS</b>	Expert Lectures, Online Seminars - Webinars on Industrial Interactions/Visits, Competitive Examinations, Employable and Communication Skill Enhancement, Social Accountability and Patriotism
<b>TEXT BOOKS</b>	<ol style="list-style-type: none"> <li>1. C. Kittel, 1996, <i>Introduction to Solid State Physics</i>, 7<sup>th</sup> Edition, Wiley, New York.</li> <li>2. Rita John, <i>Solid State Physics</i>, Tata Mc-GrawHill Publication.</li> <li>3. A. J. Dekker, <i>Solid State Physics</i>, Macmillan India, New Delhi.</li> <li>4. M. Ali Omar, 1974, <i>Elementary Solid State Physics - Principles and Applications</i>, Addison - Wesley</li> <li>5. H. P. Myers, 1998, <i>Introductory Solid State Physics</i>, 2<sup>nd</sup> Edition, Viva Book, New Delhi.</li> </ol>
<b>REFERENCE BOOKS</b>	<ol style="list-style-type: none"> <li>1. J. S. Blakemore, 1974, <i>Solid state Physics</i>, 2<sup>nd</sup> Edition, W.B. Saunder, Philadelphia</li> <li>2. H. M. Rosenburg, 1993, <i>The Solid State</i>, 3<sup>rd</sup> Edition, Oxford University Press, Oxford.</li> <li>3. J. M. Ziman, 1971, <i>Principles of the Theory of Solids</i>, Cambridge University Press, London.</li> <li>4. C. Ross-Innes and E. H. Rhoderick, 1976, <i>Introduction to Superconductivity</i>, Pergamon, Oxford.</li> <li>5. J. P. Srivastava, 2001, <i>Elements of Solid State Physics</i>, Prentice-Hall of India, New Delhi.</li> </ol>
<b>WEB SOURCES</b>	<ol style="list-style-type: none"> <li>1. <a href="http://www.physics.uiuc.edu/research/electronicstructure/389/389-cal.html">http://www.physics.uiuc.edu/research/electronicstructure/389/389-cal.html</a></li> <li>2. <a href="http://www.cmp.ucl.ac.uk/%7Eaph/Teaching/3C25/index.html">http://www.cmp.ucl.ac.uk/%7Eaph/Teaching/3C25/index.html</a></li> <li>3. <a href="https://www.britannica.com/science/crystal">https://www.britannica.com/science/crystal</a></li> <li>4. <a href="https://www.nationalgeographic.org/encyclopedia/magnetism/">https://www.nationalgeographic.org/encyclopedia/magnetism/</a></li> <li>5. <a href="https://www.brainkart.com/article/Super-Conductors_6824/">https://www.brainkart.com/article/Super-Conductors_6824/</a></li> </ol>

