Program Outcomes

PO-1: In-depth Knowledge: Acquire basic in-depth and advance knowledge by critically applying and comprehensive understanding of methodologies to address issue and question of a science discipline and attain specialization ina particular domain.

PO-2: Research and Scientific Reasoning: Apply theories, methodologies, knowledge, critical thinking,and inductive and deductive reasoning to design and drive research projects with appropriate hypothesis, experimental design, simulation, etc.

PO-3: Communication and Digital Skills: Acquire proficiency in oral and written communication skills to comprehend and write effective reports, design documents, make effective presentation, and give and receive clear instructions.

PO-4: Professional Ethics: Acquire the knowledge of ethics and values to inculcate fair practices throughout their professional life.

PO-5: Project Management: Develop and apply knowledge of science and technology, project management and finance principles, in a multidisciplinary setting, to carry out meaningful research and project work.

PO-6: Leadership Readiness: Interact with people from diverse backgrounds as both leaders/mentors and team members with integrity and professionalism.

Program Specific Outcomes

PSO1: Inculcate self-direction and originality in developing new theories, planning and conducting experiments, and developing practical research skills in tackling and problem-solving ability.

PSO2: Understanding the foundational empirical principles of Solid State Physics and Material characterization techniques, especially in respective fields of research.

PSO3: Developing knowledge of the literature and a comprehensive understanding of scientific methods and techniques applicable to their own research.

PSO4: Develop the ability to critically evaluate current research and research techniques and give outputs in the application areas of current emerging technology.

OP JINDAL UNIVERSITY

OP Jindal Knowledge Park, Punjipatra, Raigarh-496109

Department of Physics, School of Science

OPJU
UNIVERSITY OF STEEL TECHNOLOGY AND MANAGEMENT

Programme: **Ph.D in Physics** **Semester :** **I Sem**
Name of the Course: **Material Characterisation** **Course Code:** **PPH 102**

Credits : **5** **No of Hours :**
Max Marks: **100**

Course Description:

Material Characterization focuses on the theoretical basic knowledge of material synthesis and its application to engineering systems. It is an extension and deepening of the prerequisite Engineering concepts at UG level which is one of the core courses for Metallurgical and Materials Engineering graduates. The main objective of this course is to provide students with a systematic and critical study of basic scientific principles for technical problem solving in materials areas and advanced concepts of characterization techniques. Topics include classification of techniques for characterization like thermal analysis techniques, principle, construction and working principles of TEM, SEM, STEM, Atomic absorption spectrometer (AAS), Atomic Emission spectroscopy (AES), XPS (ESCA), Auger Electron Spectroscopy, FTIR, EDS & WDS, Electron Probe Micro Analysis (EPMA), Nuclear Magnetic Resonance (NMR) Techniques, X-ray diffraction and magnetization measurement processes. All these contain provide a foundation for post graduate courses and research.

COURSE OUTCOMES:

After Completion of the course Students will be able to:

CO Number	Course Outcome
CO1	Understand the relation between material structure and its properties.
CO2	Understand the principles and applications of thermal methods for material characterization
CO3	Understand the way to find the crystal structure of materials through X-ray diffraction methods.
CO4	Apply the concepts of different spectroscopic methods for material characterization.
CO5	Understand the principles and applications of different electrochemical techniques for material characterization.
CO5	Solve the different problems related to the parameters of physical and chemical properties.

Syllabus:

UNIT-I

Importance of Material characterization, Classification of techniques for characterization, Thermal Analysis techniques: Principle, Working and application of DTA, TGA, TMA and DSC

UNIT-II

Principle, Construction and Working of TEM, SEM, STEM with their merits, demerit and applications, techniques of replica preparation, UV-Visual(UV-VIS), IR & Raman spectroscopy, X-ray Fluoroscopy (XRF), Atomic absorption spectrometer(AAS), Atomic Emission spectroscopy (AES), XPS (ESCA), Auger Electron Spectroscopy.

UNIT-III

FTIR, EDS & WDS; Electron Probe Micro Analysis (EPMA); Nuclear Magnetic Resonance (NMR) Technique.

UNIT-IV

Diffraction method; X-ray diffraction, determination of crystal structure, lattice parameter, crystallite size by diffraction techniques / low angle X-ray scattering technique.

UNIT-V

Electrical resistivity in bulk and thin films, Hall effect, Magneto resistance, Impedance spectroscopy, Magnetic property measurements, Magnetic hysteresis loops, time and temperature dependent magnetization measurement.

Resources

Name of Text and Reference Books:

- F. Weinberg, Editor, Tools & Techniques in Physical Metallurgy, Vol. I & Vol. II, Marcel Dekker, 1970.
- John P. Sibilia, A guide to Material Characterization & Chemical Analysis, VCH Publishers, 1988.
- J.M. Walls, Editor, Methods of Surface Analysis: Techniques & Applications, Cambridge University Press, 1990.
- B.D. Cullity, Elements of X-ray diffraction, Addison-Wesley Publishing Company, INC, 1978.
- Bernhard Wounderlich, Thermal Analysis, Academic Press, INC, 1990.
- B.L. Gabriel, SEM: A user's manual for materials Science, American Society for Metals, 1985.
- An Introduction to Materials Characterization by P. R. Khangaonkar, Penram International Publishing (India) Pvt. Ltd.

CO-PO&PSO Correlation

Course Name : Material Characterisation										
	Program Outcomes						PSOs			
Course Outcomes	1	2	3	4	5	6	1	2	3	4
CO1:	2	2	1	1	2	1	1	3	2	2
CO2:	2	1	1	1	2	1	2	3	1	2
CO3:	1	2	1	1	2	1	1	2	2	1
CO4:	2	1	1	2	1	1	2	3	1	1
CO5:	1	1	2	2	1	1	1	2	2	2

Note: 1: Low 2.: Moderate 3: High

Programme: **Ph.D in Physics** **Semester :** **I Sem**

Name of the Course: **Solid State Physics & Material Science** **Course Code:** **PPH 103**

Credits : **5** **No of Hours :**

Max Marks: **100**

Course Description:

This course provide understanding of the concepts in Solid State Physics and Material Science, various methods of synthesis, and techniques used for analysis.

COURSE OUTCOMES:

After Completion of the course Students will be able to:

CO Number	Course Outcome
CO1	Understand the basic knowledge of crystal systems and spatial symmetries
CO2	Understand and perform structure determination of simple structures
CO3	Understand the space and point groups in crystals and application of X-ray diffraction technique for crystal structure elucidation
CO4	Understand the Synthesis of materials in different routes and their impact on their mechanical and chemical properties

CO5	Understand the fundamentals of photonics and photonic devices and their luminescence characterization
CO5	Understand the basic knowledge of crystal systems and spatial symmetries

Syllabus:

Unit I

Space lattice and unit cell of a crystal, Choice of a unit cell, Crystal systems, Bravais lattices, Crystal faces and internal arrangement, Miller indices, Law of rational indices, Indices of a direction. Point groups, Space groups. Perspective projections: Gnomonic projection, Stereographic projection, Orthographic projection. Reciprocal lattice concept: Graphical construction, Relation to interplanar spacing, Interpretation of Bragg's law.

Unit II

Production of X-rays: Continuous and characteristic X-ray spectra. X-ray emission from thick and thin targets. Efficiency of X-ray production. White radiation, absorption of X-Ray, filters, fundamental principles of X-Ray diffraction. Braggs law,

Unit III

Synthesis of materials: High energy Ball Milling, Melt mixing, Synthesis of metal & semiconductor material by colloidal route, Sol-gel method, Combustion method, Wet chemical method, solid state reaction method.

Unit IV

Radiation Sources, Detectors and Sensors Different types of radiations (X-rays, UV-VIS, IR, microwaves and nuclear) and their sources Detectors: gamma-rays, X-rays, UV-VIS, IR, microwaves detectors.

Unit- V

Fundamentals of photonics and photonic devices, Lasers, CFLs, LEDs, OLEDs, Wall paper lighting, Display devices, X-ray imaging phosphers, Photo therapy lamps and its applications, materials for radiation, Dosimetery special for lyoluminescence, mechanoluminescence, thermoluminescence. Optical stimulated luminescence, Luminescence solar concentration. Basic principles of photodetector and solar cell, device fabrication and testing, different device designs, materials-based different types of potodetectors and solar cells and their applications.

Resources

Name of Text and Reference Books:

- C. Kittel: Introduction to Solid State Physics (Wiley and Sons).

- J.M.Ziman: Principles of theory of solids (Cambridge Univ.Press).
- Azaroff: X-ray crystallography.
- Weertman and weertman : Elementary Dislocation Theory.
- Verma and Srivastava: Crystallography for Solid State Physics.
- Azeroff and Buerger: The Power Method.

CO-PO&PSO Correlation

Course Name : Solid State Physics & Material Science										
	Program Outcomes						PSOs			
Course Outcomes	1	2	3	4	5	6	1	2	3	4
CO1:	1	1	2	1	2	1	1	3	2	2
CO2:	2	3	1	1	2	1	1	3	1	2
CO3:	1	2	1	1	2	1	2	2	2	1
CO4:	2	3	1	2	1	1	2	3	2	1
CO5:	1	3	2	2	1	1	1	2	2	2

Note: 1: Low 2.: Moderate 3: High