15PY102L	**MATERIALS SCIENCE**	**L**	**T**	**P**	**C**
		2	**0**	**2**	**3**
	Total Contact Hours - 60				
	Prerequisite				
	Nil				

PURPOSE

The course introduces several advanced concepts and topics in the rapidly evolving field of material science. Students are expected to develop comprehension of the subject and to gain scientific understanding regarding the choice and manipulation of materials for desired engineering applications.

INSTRUCTIONAL OBJECTIVES

1.	To acquire basic understanding of advanced materials, their functions and properties for technological applications
2.	To emphasize the significance of materials selection in the design process
3.	To understand the principal classes of bio-materials and their functionalities in modern medical science
4.	To get familiarize with the new concepts of Nano Science and Technology
5.	To educate the students in the basics of instrumentation, measurement, data acquisition, interpretation and analysis

UNIT I–ELECTRONIC AND PHOTONIC MATERIALS (6 hours)

Electronic Materials: Fermi energy and Fermi - Dirac distribution function - Variation of Fermi level with temperature in intrinsic and extrinsic semiconductors - Hall effect - Dilute Magnetic Semiconductors (DMS) and their applications

Superconducting Materials: Normal and High temperature superconductivity - Applications.

Photonic Materials: LED – LCD - Photo conducting materials - Photo detectors - Photonic crystals and applications - Elementary ideas of Non-linear optical materials and their applications.

UNIT II– MAGNETIC AND DIELECTRIC MATERIALS (6 hours)

Magnetic Materials: Classification of magnetic materials based on spin - Hard and soft magnetic materials - Ferrites, garnets and magnetoplumbites - Magnetic bubbles and their applications - Magnetic thin films - Spintronics and devices (Giant magneto resistance, Tunnel magneto resistance and Colossal magneto resistance).

Dielectric Materials: Polarization mechanisms in dielectrics - Frequency and temperature dependence of polarization mechanism - Dielectric loss - Dielectric waveguide and dielectric resonator antenna - Piezoelectric, pyroelectric and ferroelectric materials and their applications.

UNIT III– MODERN ENGINEERING AND BIOMATERIALS (6 hours)

Modern Engineering Materials: Smart materials - Shape memory alloys - Chromic materials (Thermo, Photo and Electro) - Rheological fluids - Metallic glasses - Advanced ceramics - Composites.

Bio-materials: Classification of bio-materials (based on tissue response) - Comparison of properties of some common biomaterials - Metallic implant materials (stainless steel, cobalt-based and titanium-based alloys) - Polymeric implant materials (Polyamides, polypropylene, Acrylic resins and Hydrogels) -Tissue replacement implants - Tissue engineering - Biosensor.

UNIT IV– INTRODUCTION TO NANOSCIENCE AND NANOTECHNOLOGY (6 hours)

Basic concepts of Nanoscience and Nanotechnology - Quantum wire - Quantum well - Quantum dot - fullerenes - Graphene - Carbon nanotubes - Material processing by chemical vapor deposition and physical vapor deposition - Principle of SEM, TEM, AFM, Scanning near-field optical microscopy (SNOM) - Scanning ion-conducting microscopy (SCIM)- Potential uses of nanomaterials in electronics, robotics, computers, sensors, sports equipment, mobile electronic devices, vehicles and transportation- Medical applications of nanomaterials.

UNIT V– MATERIALS CHARACTERIZATION (6 hours)

X-ray diffraction, Neutron diffraction and Electron diffraction - X-ray fluorescence spectroscopy - Fourier transform Infrared spectroscopy (FTIR) - Ultraviolet and visible spectroscopy (UV-Vis) - Thermogravimetric Analysis (TGA) - Differential Thermal Analysis (DTA) - Differential Scanning Calorimetry (DSC).

LABORATORY EXPERIMENTS (30 hours)

1. Determination of resistivity and band gap for a semiconductor material - Four probe method / Post-office box
2. Determination of Hall coefficient for a semiconducting material
3. To study V-I characteristics of a light dependent resistor (LDR)
4. Determination of energy loss in a magnetic material - B-H curve
5. Determination of paramagnetic susceptibility - Quincke’s method

6. Determination of dielectric constant for a given material
7. Calculation of lattice cell parameters - X-ray diffraction
8. Measurement of glucose concentration - Electrochemical sensor
9. Visit to Advanced Material Characterization Laboratory (Optional)

- This course consists of theory and laboratory components carrying equal weightage for assessment.

TEXT BOOKS

1. Thiruvadigal, J. D., Ponnusamy, S., Sudha. D. and Krishnamohan, M., "*Materials Science"*, SSS Publication, Chennai, 2015.

2. Rajendran, V. "*Materials Science*",Tata McGraw- Hill,New Delhi,2011.

REFERENCES

1. Rolf E. Hummel, "*Electronic Properties of Materials"*, 4th ed., Springer, New York, 2011.
2. Dennis W. Prather, "*Photonic Crystals: Theory, Applications, and Fabrication"*, John Wiley & Sons, Hoboken, 2009.
3. James R. Janesick, "*Scientific Charge-Coupled Devices"*, Published by SPIE - The International Society for Optical Engineering, Bellingham, Washington, 2001.
4. David M. Pozar, "*Microwave Engineering*", 3rd ed., John Wiley & Sons, 2005.
5. Silver F. and Dillion C., "*Biocompatibility: Interactions of Biological and Implantable Materials*", VCH Publishers, New York, 1989.
6. Severial Dumitriu, "*Polymeric Biomaterials*" Marcel Dekker Inc, CRC Press, Canada 2001.
7. Cao G., "*Nanostructures and Nanomaterials: Synthesis, Properties and Applications*", Imperial College Press, 2004.
8. Pradeep T., "*A Text Book of Nanoscience and Nanotechnology*", Tata McGraw Hill, New Delhi, 2012.
9. Sam Zhang, "*Materials Characterization Techniques*", CRC Press, 2008.

15PY102L MATERIALS SCIENCE												
Course designed by		**Department of Physics and Nanotechnology**										
1	Student Outcome	a	b	c	d	e	f	g	h	i	j	k
		x	x		x	x						x
2	Mapping of instructional objectives with student outcome	1	5		4	2						3
3	Category	General (G)		Basic Sciences (B)		Engineering Sciences and Technical Arts (E)					Professional Subjects (P)	
		--		x		--					--	
4	Approval											