University of Kerala

Discipline	**PHYSICS**				
Course Code	**UK1DSCPHY102**				
Course Title	**PROPERTIES OF SOLIDS**				
Type of Course	**DSC**				
Semester	**I**				
Academic Level	**100 - 199**				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	4	3 Hrs	-	2 Hrs	5 Hrs
Pre-requisites	1. Students should have a basic understanding of states of matter and chemical bonding. 2. Students should be aware of basics of diamagnetic, paramagnetic, and ferro magnetic substances. 3. Students should know the fundamentals of heat, temperature, thermal expansion and heat transfer by conduction, convection and radiation. 4. Students should be familiar with foundation of semiconductor electronics.				
Course Summary	This course explores the fundamental properties of solids and their applications in semiconductor devices. Topics covered include magnetic properties, superconductivity, thermal properties, dielectric properties and semiconductor devices. Emphasis is placed on understanding the underlying concepts of physics governing these properties and their technological significance.				

BOOKS FOR STUDY:

1. Physics, Principles with Applications, Douglas C. Giancoli, Pearson Education Limited, 7th Edition (2016).
2. Engineering Physics, G Aruldhas, PHI Learning Private Limited, New Delhi(2012).

3. Heat and Thermodynamics: Brijlal and Subramaniam, S. Chand &Co.

BOOKS FOR REFERENCE:

1. Concepts of Modern Physics, Arthur Beiser, Shobhit Mahajan, S Rai Choudhury, McGraw Hill Education (India) Private Limited (2017).
2. Solid State physics and Electronics, R K Puri, V K Babbar, S Chand & Company Ltd, (2008).
3. Solid State Physics, Dr R Asokamani, Eswar Press, Chennai, (2015).
4. Applied Solid State Physics, Rajnikant, Wiely India Pvt. Ltd. 92011)
5. Heat and Thermodynamics: M. Zeemansky, McGraw Hill, New Delhi (2007).
6. Heat and Thermodynamics: Rose C. McCarthy, The Rosen Publishing Group, Inc. NY,(2005)
7. Thermodynamics Kinetic Theory and Statistical Thermodynamics: F. W. Sears and G.
8. L. Salinger, Addison-Wesley Publishing Company, 3rd Edn. (1975).

DETAILED SYLLABUS: THEORY

Module	Unit	Content	Hrs	CO No
I		**MOLECULES AND SOLIDS (Book 1)**	**8**	
	1	Bonding in molecules, Potential Energy diagrams for molecules, Weak (Van der Waals) bonds – Protein synthesis,	2	1
	2	Bonding in solids	1	1
	3	Free electron theory of metals	2	1
	4	Band theory of solids, Semiconductors and doping, Semiconductor Diodes, LEDs, OLEDs, Transistors: Bipolar and MOSFETs, Integrated Circuits, 22-nm Technology	3	1,6
II		**MAGNETIC PROPERTIES (Book 2)**	**10**	
	5	Permeability and Susceptibility	1	2
	6	Origin of Magnetic Moment	1	1,6
	7	Classification of magnetic materials	2	2

	8	Curie Temperature, Weiss theory of Ferromagnetism	1	2
	9	Hysteresis loop	2	2
	10	Antiferromagnetism, Ferrimagnetism, Ferrites, Magnetic materials for information storage	3	2
III	**SUPERCONDUCTIVITY (Book 2)**		**8**	
	11	Introduction, Magnetic Properties, Meissner Effect	2	3
	12	Type I and type II superconductors – London Penetration depth	2	3
	13	Isotope Effect, BCS Theory, Cooper Pairs	2	3
	14	High temperature superconductivity, Applications	2	3
IV	**THERMAL PROPERTIES (Book 3)**		**10**	
	15	Coefficient of Thermal Conductivity, Thermometric Conductivity	1	4
	16	Thermal conductivity – Radial flow of heat, cylindrical flow	2	4,6
	17	Wiedemann – Franz Law	1	4
	18	Latent Heat of Fusion	1	4
	19	Laws of Fusion - Practical Applications	1	4
	20	Effect of Pressure and impurities on Freezing point,	1	4
	21	Thermoelectric effects – Seebeck, Peltier, Thomson effect and Thermo electric power	3	4
V*	**DIELECTRIC PROPERTIES (Book 2)**		**9**	
	22	Electric Dipole, Polarizability, Polarisation vector, Dielectric constant, Dielectric Susceptibility	2	5
	23	Dielectric polarisation- Electronic Polarisation, Ionic Polarisation, Orientation Polarisation, Space Charge Polarization, Total Polarisation	3	5

	24	Frequency dependence of Polarisation, Dielectric loss	2	5
	25	Ferroelectric Crystals, Piezoelectric Crystals- Applications	1	5
	26	Applications of dielectric materials	1	5

DETAILED SYLLABUS: PRACTICALS

Part A – At least 5 Experiments to be performed		**CO No**
Sl No	**Name of Experiment**	
1	Diode Characteristics (for Ge and Si diodes)	6
2	Zener diode characteristics: To (i) trace and construct the circuit (ii) to plot the V-I characteristicunder reverse biased condition and (iii) to calculate the dynamic resistance of the diode under reverse bias when conducting	6
3	Phase transition-determination of M.P of wax	6
4	Determination of thermal conductivity of rubber	6
5	Lee's disc-determination of thermal conductivity of a bad conductor	6
6	Circular coil- magnetization of a magnet	6
7	Absolute determination of m and B_h using box type and Searle's type vibrationmagnetometers	6
8	Searle's vibration magnetometer-comparison of magnetic moments	6
9	Potentiometer – Resistivity	6
Part B* – At least One Experiment to be performed		
10	Thermo emf-measurement of emf using digital multimeter	6
11	Determination of dielectric constant of a given material	6
12	Carey Foster's Bridge-Resistivity	6

COURSE OUTCOMES

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO-1	Differentiate various types of bonding in solids, describe the relationship between band structure and electrical properties and apply the principles of doping in the fabrication of semiconductor devices	U, Ap	PSO-1,2
CO-2	Illustrate and interpret the magnetic properties of materials and their theoretical underpinnings crucial for different applications	U, Ap	PSO-1,2
CO-3	Explain the principles of superconductivity, describe the properties of superconducting materials, and evaluate the wide range of applications of superconductivity	U, Ap	PSO-1,2
CO-4	Describe and apply the thermal conductivity principles of solids, analyse the latent heat of fusion and evaluate its applications and analyse the thermoelectric properties of solids	U, Ap, An	PSO-1,2
CO-5	Describe the principles governing dielectric materials and categorise different types of dielectric crystals and appraise their application.	U, Ap	PSO-1,2
CO-6	Experiment and infer conductivity and magnetic property measurements as well as semiconductor device characterization.	Ap, An	PSO-1,2, 7

R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create

Name of the Course: PROPERTIES OF SOLIDS

Credits: 3:0:1 (Lecture: Tutorial: Practical)

CO No.	CO	PO / PSO	Cognitive Level	Knowledge Category	Lecture (L)/ Tutorial (T)	Practical (P)
CO-1	Differentiate various types of bonding in solids, describe the relationship between band structure and electrical properties and apply the principles of doping in the fabrication of semiconductor devices	PO 1, 2, 3, 4, 5, 8/ PSO – 1,2	U, Ap	C	L	-
CO-2	Illustrate and interpret the magnetic properties of materials and their theoretical underpinnings crucial for different applications	PO 1, 2, 3, 4, 6, 8/ PSO – 1,2	U, Ap	C	L	-
CO-3	Explain the principles of superconductivity, describe the properties of superconducting materials, and evaluate the wide	PO 1, 2, 3, 4, 8/ PSO – 1,2	U, Ap	C	L	-

	range of applications of superconductivity					
CO-4	Describe and apply the thermal conductivity principles of solids, analyse the latent heat of fusion and evaluate its applications and analyse the thermoelectric properties of solids	PO 1, 2, 3, 4, 5, 8/ PSO – 1,2	U, Ap, An	C	L	-
CO-5	Describe the principles governing dielectric materials and categorise different types of dielectric crystals and appraise their application.	PO 1, 2, 3, 4, 8/ PSO – 1,2	U, Ap	C	-	-
CO-6	Experiment and infer conductivity and magnetic property measurements as well as semiconductor device characterization.	PO 1, 2, 3, 4, 5, 6, 8/ PSO – 1,2,7	Ap, An	P	-	P

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs :

	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8
CO-1	3	2	-	-	-	-	-	3	3	2	1	1	-	-	1
CO-2	3	3	-	-	-	-	-	3	3	2	1	-	1	-	1
CO-3	3	3	-	-	-	-	-	3	3	3	1	-	-	-	1
CO-4	3	3	-	-	-	-	-	3	3	3	1	1	-	-	1
CO-5	3	3	-	-	-	-	-	3	3	3	2	-	-	-	1
CO-6	3	3	-	-	-	-	3	3	3	3	3	3	3	-	3

Correlation Levels:

Level	-	1	2	3
Correlation	Nil	Slightly / Low	Moderate / Medium	Substantial / High

Assessment Rubrics:

- Quiz / Assignment/ Discussion / Seminar
- Midterm Exam
- Programming Assignments
- Final Exam

Mapping of COs to Assessment Rubrics :

CO No	Internal Exam	Assignment	Project Evaluation	End Semester Examinations
CO-1	✓	-	-	✓
CO-2	✓	✓	-	✓
CO-3	✓		-	✓
CO-4	-	✓	-	✓
CO-5	✓	-	-	-
CO-6	✓	-	✓	-