

Course Code	Course Title	L	T	P	C
BEVD101L	Electronic Materials	3	0	0	3
Pre-requisite	NIL	Syllabus version			
		1.0			
<b>Course Objectives</b>					
This course is aimed to:					
<ol style="list-style-type: none"> <li>1. Give the students a solid background, in relevant concepts, principles, and properties of electronic materials which are constituents of modern semiconductor devices.</li> <li>2. Understand and comprehend basic materials physics and materials properties and use them for device application.</li> <li>3. Correlate electronic materials properties with the semiconductor device characteristics.</li> </ol>					
<b>Course Outcomes</b>					
After completion of the course, the student will be able to:					
<ol style="list-style-type: none"> <li>1. Learn and understand the concept of crystal structures and their defects.</li> <li>2. Know the classical and quantum theory of materials.</li> <li>3. Learn and understand the optical and thermal properties of materials.</li> <li>4. Know the dielectric, ferroelectric, and magnetic properties of materials.</li> <li>5. Understand the concept of superconductivity in materials.</li> <li>6. Gain knowledge about various kinds of nanomaterials.</li> </ol>					
<b>Module:1</b>		<b>Crystal structures, Defects</b>			<b>6 hours</b>
Crystal system and Bravais lattices -Crystal structures Crystallographic planes and directions - Defects and imperfection in crystals - Analysis of crystal structures - X-ray diffraction - Bragg's law, Reciprocal lattice, Amorphous solids.					
<b>Module:2</b>		<b>Classical theory of materials</b>			<b>6 hours</b>
Drude-Lorentz Classical free electron theory of metals, electrical conductivity, relaxation time, drift velocity, Matthiessen's rule, Temperature dependence of resistivity, Thermal conductivity, Wiedemann-Franz law, drawbacks of classical theory, Hall effect - theory - experimental proof; Hall Sensors.					
<b>Module:3</b>		<b>Quantum Theory of Materials</b>			<b>8 hours</b>
Need for quantum mechanics, Schrodinger equation - Tunnel barrier, Electronic structure of H atom, Harmonic oscillator - H <sub>2</sub> molecule, Electronic Band structure - free electron band, electron in a one-dimensional potential well, Bloch theorem, Kronig-Penny Model, k-space, Brillouin Zone, Fundamentals of Metals, semiconductors and insulators (properties of materials useful for device application), Fermi-Dirac statistics, Fermi energy, Fermi Surface, effective mass. Electronic band models (E-k diagram) of representative metals, semiconductors and insulators, Density of states. Electrons, holes, excitons.					
<b>Module:4</b>		<b>Thermal &amp; Optical properties of Materials</b>			<b>6 hours</b>
Lattice vibrations - Harmonic oscillator and lattice waves, Phonons and Thermal properties: Monatomic, diatomic harmonic crystals, phonons, sound velocity, Heat Capacity - Debye model - Phonon density of states, Einstein model. Optical Properties - Photoconductivity, Optical absorption and transmission, Photoluminescence, Electroluminescence.					

<b>Module:5</b>	<b>Dielectric, Ferroelectric, Piezoelectric, &amp; Magnetic properties of materials</b>	<b>7 hours</b>	
Insulators & Dielectric materials, Polarization, Clausius - Mosotti relation, Dielectric constant, Temperature & frequency dependence of dielectric constant, Dielectric loss, breakdown. Ferroelectric and Piezoelectric materials, and their applications in devices. Magnetic parameters and their relations - Origin of magnetization - orbital magnetic moment, spin magnetic moment, Bohr magneton, Properties (Qualitative description) of dia, para, antiferro and ferromagnetic materials - Domain theory of ferromagnetism, Hysteresis, applications.			
<b>Module:6</b>	<b>Superconductivity</b>	<b>5 hours</b>	
Superconductors, types, properties, Meissner Effect - Effect of Magnetic Field - Critical Current Superelectrons - electrodynamics of Superelectrons - Penetration depth - BCS theory - Josephson Effect - Applications - SQUID.			
<b>Module:7</b>	<b>Nanomaterials</b>	<b>5 hours</b>	
Fundamentals of Quantum wells, Quantum wires, Quantum dots and their applications.			
<b>Module:8</b>	<b>Contemporary Issues</b>	<b>2 hours</b>	
Guest lecture from Industries and R & D Organizations			
<b>Total Lecture Hours:</b>		<b>45 hours</b>	
<b>Text Book(s)</b>			
1.	Safa O. Kasap, Principles of Electronic Materials and Devices, 2018, 4 <sup>th</sup> Edition, McGraw-Hill Education.		
2.	Rolf E. Hummel, Electronic Properties of Materials, 2014, 4 <sup>th</sup> Edition, Springer.		
<b>Reference Books</b>			
1.	David Jiles, Introduction to the Electronic Properties of Materials, 2017, 2 <sup>nd</sup> Edition, CRC Press.		
2.	Manijeh Razeghi, Fundamentals of Solid-State Engineering, 2019, 4 <sup>th</sup> Edition, Springer.		
3.	Charles Kittel, Introduction to Solid-State Physics, 2019, 8 <sup>th</sup> Edition, Wiley India.		
4.	M. A. Wahab, Solid State Physics - Structure and Properties of Materials, 2021, 3 <sup>rd</sup> Edition, Narosa Publishing House.		
5.	Paul Harrison and Alex Valavanis, Quantum Wells, Wires and Dots, 2016, 4 <sup>th</sup> edition, John Wiley.		
Mode of Evaluation: Continuous Assessment Test, Digital Assignment, Quiz and Final Assessment Test			
Recommended by Board of Studies	03-11-2023		
Approved by Academic Council	No. 72	Date	13-12-2023