

| BEEE201L  | Electronic Materials                       | L                       | T | P | C |
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|   |  | 3                       | 0 | 0 | 3 |
| <b>Pre-requisite</b>  | <b>NIL</b>                                 | <b>Syllabus version</b> |   |   |   |
|   |  | <b>1.0</b>              |   |   |   |
| <b>Course Objectives</b>  |  |                         |   |   |   |
| <ol style="list-style-type: none"> <li>1. Familiarize the relevant concepts, principles and characteristics of electronic materials.</li> <li>2. Understand and comprehend the various laws and mechanisms of semiconductor, dielectric and magnetic materials.</li> <li>3. Analyze and compare the unique properties, characteristics and applications of materials in electronic devices.</li> </ol>  |  |                         |   |   |   |
| <b>Course Outcomes</b>  |  |                         |   |   |   |
| On completion of this course, the students will be able to: <ol style="list-style-type: none"> <li>1. Understand the fundamental physics of electronic materials.</li> <li>2. Classify and interpret various types of current carrying mechanisms in semiconductor materials.</li> <li>3. Comprehend the categories of magnetic materials and its characteristics.</li> <li>4. Analyze the various types of dielectric materials based on the nature of electric field.</li> <li>5. Distinguish and examine the various optical properties of materials.</li> </ol> |  |                         |   |   |   |
| <b>Module:1</b>   | <b>Physics of Materials</b>                | <b>6 hours</b>          |   |   |   |
| Atomic structure and atomic number, electron spin and Pauli's exclusion principle, bonding and types of solids, concepts of Fermi level, energy bands in solids; Classification of materials - metals, semiconductors and insulators; Potential barrier problems, crystal directions and planes, crystal properties, defects and vacancies.   |  |                         |   |   |   |
| <b>Module:2</b>   | <b>Semiconductor Materials</b>             | <b>10 hours</b>         |   |   |   |
| Classification of semiconductors, doping of semiconductor, temperature dependence, metal-semiconductor junction; Carrier concentration, carrier generation and recombination, Carrier actions, diffusion and conduction equations, continuity equation; Organic semiconductor; Direct and indirect band gaps, optical absorption, Piezo-resistivity; Applications of semiconductor materials: PN junction diodes, BJT, JFET, MOSFET.  |  |                         |   |   |   |
| <b>Module:3</b>   | <b>Magnetic Materials</b>                  | <b>6 hours</b>          |   |   |   |
| Classification of magnetic materials, concept of ferromagnetism, saturation magnetization, Curie and Neel temperature; Temperature dependence of conductivity materials; Magnetostriction, magnetic anisotropy, spin-orbit interaction; Superconductivity.  |  |                         |   |   |   |
| <b>Module:4</b>   | <b>Dielectric Materials and Insulation</b> | <b>8 hours</b>          |   |   |   |
| Requirements of insulating materials: Electrical and molecular properties, dependence of permittivity on temperature, pressure & humidity; Dipole moment and electronic polarization, Clausius-Mossotti equation, polarization mechanisms; Behaviour of dielectrics under static and alternating fields; Frequency dependence; Complex dielectric constants and dielectric loss, bipolar relaxation and characteristics.  |  |                         |   |   |   |
| <b>Module:5</b>   | <b>Optical Properties of Materials</b>     | <b>8 hours</b>          |   |   |   |
| Light propagation in a homogeneous medium, refractive index, group velocity and group index, complex refractive index and light absorption; Light scattering, attenuation in optical fibers; Luminescence, phosphors, Light Emitting Diode (LED), Liquid Colour Display (LCD), electro optic effects.   |  |                         |   |   |   |

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| <b>Module:6</b>  | <b>Semiconductor Nanomaterials</b>   | <b>5 hours</b>              |                 |
| Flexible energy storage devices, flexible chemical sensors, flexible solar cells |  |                             |                 |
| <b>Module:7</b>  | <b>Contemporary Issues</b>   | <b>2 hours</b>              |                 |
|  |  |                             |                 |
|  |  | <b>Total Lecture hours:</b> | <b>45 hours</b> |
| <b>Text Book(s)</b>  |  |                             |                 |
| 1.   | S.O. Kasap, Principles of Electronic Materials and Devices, 2018, 4 <sup>th</sup> Edition, McGraw Hill Education   |                             |                 |
| 2.   | Yugang Sung, John A Rogers, William Andrew, Semiconductor Nanomaterials for Flexible Technologies: From Photovoltaics and Electronics to Sensors and Energy Storage/ Harvesting Devices, 2010, 1 <sup>st</sup> Edition, Elsevier |                             |                 |
| <b>Reference Books</b>   |  |                             |                 |
| 1.   | T.K. Basak, Electrical Engineering Materials, 2012, 1 <sup>st</sup> Edition, New Academic Science Limited  |                             |                 |
| 2.   | Rolf E. Hummel, Electronic Properties of Materials, 2001, 3 <sup>rd</sup> Edition, Springer  |                             |                 |
| 3.   | C. S. Indulkar, S. Thiruvengadam, An Introduction to Electrical Engineering Materials, 2011, 6 <sup>th</sup> Edition, S. Chand & Company   |                             |                 |
| Mode of Evaluation: CAT, Digital Assignments, Quiz and FAT                       |  |                             |                 |
| Recommended by Board of Studies  |  | 30-10-2021                  |                 |
| Approved by Academic Council   |  | No. 64                      | Date 16-12-2021 |