203142: Material Science

Teaching Scheme	Credits	Examination Scheme [Marks]
Th:04 Hrs/ Week	Th/Tut: 04	In Sem (Online):50 Marks
PR:02 Hrs/ Week	PR:01	End Sem : 50 Marks
		Oral :50 Marks

Prerequisite:

- Students should have knowledge of various classes of materials like solid, liquid, gaseous, conducting, insulating and resistive along with their basic characteristics.

Course Objective:

- To classify different materials from Electrical Engineering application point of view.
- To understand various properties and characteristics of different classes of materials.
- To select materials for applications in various electrical equipment.
- Toimpart knowledge of Nano-technology, battery and solar cell materials.
- Todevelop ability to test different classes of materials as per IS.

Course Outcome: Upon successful completion of this course, the students will be able to :-

- Categorize and classify different materials from Electrical Engineering applications point of view.
- Explain and summarize various properties and characteristics of different classes of materials.
- Choose materials for application in various electrical equipment.
- Explain and describe knowledge of nanotechnology, batteries and solar cell materials.
- Test different classes of materials as per IS.

Unit 01 A] : Dielectric Properties of Insulating Materials: (6Hrs)

Static Field, Parameters of Dielectric material [Dielectric constant, Dipole moment, Polarization, Polarizability], Introduction to Polar and Non- Polar dielectric materials. Mechanisms of Polarizations-Electronic, Ionic and Orientation Polarization (descriptive treatment only), ClausiusMossotti Equation, Piezo-Electric, Pyro-Electric & Ferro-Electric Materials, Dielectric loss and loss tangent, Concept of negative tan delta (δ).

Unit 01 B] : Optical Properties of Materials: (2 Hrs)

Comparison between materials used for Photo-Conductive, Photo-Electric Emissive and Photo-Voltaic cell. Different materials used for plastic, organic and thin-film solar cells (Mono-Crystalline, Poly-Crystalline). Introduction to fiber optics, materials used and its applications.

Unit 02 A] : Insulating Materials, Properties & Applications: (6Hrs)

Introduction, Characteristics of Good Insulating Material, Classification, Solid Insulating Materials-Paper, Press Board, Fibrous Materials, Ceramics, Mica, Asbestos, Resins, Amorphous materials Polymers, Ceramics, Enamels. Liquid Insulating Materials such as Transformer Oil, Varnish, Askarel. Insulating Gases like Air, SF_6. Insulating Materials for Power & Distribution Transformers, Rotating Machines, Capacitors, Cables, Line Insulators and Switchgears.

Unit 02 B] : Dielectric Breakdown: (2 Hrs)

Introduction, Concept of Primary and Secondary Ionization of Gases (descriptive treatment only), Breakdown Voltage, Breakdown Strength, Factors affecting Breakdown Strengths of Solid, Liquid and Gaseous dielectric materials.

Unit 03 : Magnetic Materials: (8Hrs)
Introduction, Parameters of Magnetic material [Permeability, Magnetic Susceptibility, Magnetization], Classification of Magnetic Materials, Diamagnetism, Paramagnetism, Ferromagnetism, Ferri-magnetism, Ferro-magnetic behavior below Critical Temperature, Spontaneous Magnetization, Curie-Weiss law, Anti-ferromagnetism, Ferrites, Applications of Ferro-magnetic Materials, Magnetic materials for Electric Devices such as Transformer Core , Core of Rotating Machines, Soft Magnetic Materials, Hard Magnetic Materials, Magnetic Recording Materials, Compact Discs. Introduction to laser and magnetic strip technology.

Unit 04 : Conducting Materials: (8Hrs)
General Properties of Conductor, Electrical Conducting Materials - Copper, Aluminum and its applications, Materials of High & Low Resistivity-Constantan, Nickel-Chromium Alloy, Tungsten, Canthal, Silver & Silver alloys, Characteristics of Copper Alloys (Brass & Bronze), Materials used for Lamp Filaments, Transmission Lines, Electrical Carbon Materials, Materials for Super-capacitors. Material used for Solders, Metals & Alloys for different types of Fuses, Thermal Bimetal & Thermocouple. Introduction to Superconductivity and Super Conductors.

Unit 05 A] : Nanotechnology: (6Hrs)
Introduction, Concepts of Energy bands & various Conducting Mechanism in Nano-structures, Carbon Nano-structures, Carbon Molecules, Carbon Clusters, Carbon Nano-tubes and applications. Special Topics in Nano Technology such as Single Electron Transistor, Molecular Machines, BN Nanotubes, Nano wires.

Unit 05 B] : Batteries: (2 Hrs)
Materials used for Batteries: Lead Acid, Lithium-ion, Sodium-Sulphur, Nickel-Cadmium, Zero Emission Battery Research Activity (ZEBRA) Batteries. Batteries used in Electric Vehicle (EV) and Electric Hybrid Vehicle (EHV).

Unit 06 : Testing of Materials: (8Hrs)
Explanation of following with objectives, equipment required, circuit diagrams and observations to be taken.

1. Measurement of Dielectric Loss Tangent (tan δ) by Schering Bridge-IS 13585-1994.
2. Measurement of Dielectric Strength of Solid Insulating Material-IS 2584.
3. Measurement of Dielectric Strength of Liquid Insulating Material – IS 6798.
4. Measurement of Dielectric Strength of Gaseous Insulating Material as per IS.
5. Measurement of Flux Density by Gauss-meter.

Guidelines for Instructor's Manual

Practical Sessions:-

Instructor's Manual should contain following things related to every experiment-

1. The circuit diagram of the experiment should be drawn at the start.
2. Aim, apparatus, theory related to that experiment should be written.
3. One sample calculation should be shown, result table should be made and graph should be plotted if required.
4. Conclusion based on calculations, result and graph (if any) should be written.
5. Five - six questions based on that experiment should be written at the end.

Guidelines for Student's Lab Journal

Student's Lab Journalshould be **Hand Written/ Drawn** containing, following things related to every experiment-

1. The circuit diagram of the experiment should be drawn on the graph paper at the start of the experiment.
2. Aim, apparatus, theory related to that experiment should be written.
3. One sample calculation should be shown, result table should be made and graph should be plotted if required.
4. Conclusion based on calculations, result and graph (if any) should be written.
5. Students should write answers to five - six questions based on that experiment at the end.

Guidelines for Lab /TW Assessment

There is **no Term Work** for the subject. But continuous assessment should be carried out such as checking of previous experiment along with its mock oral session (minimum 4-5 questions to each student), while conducting new experiment.

Guidelines for Laboratory Conduction

1. The circuit diagram should be explained to students in such a way that they should be able to develop it at their own.
2. Detail explanation of the experiment along with its circuit diagram, observation table, calculations, result table and plotting of graphs (if any).
3. While conducting new experiment, assessment of previous experiment should be carried out by its checking along with its mock oral session (minimum 4 -5 questions to each student).

List of Experiments: (Any **eight experiments** from the list below).

1. To measure dielectric strength of solid insulating materials.
2. To measure dielectric strength of liquid insulating materials.
3. To measure dielectric strength of gaseous insulating materials using Sphere Gap-Unit.
4. To obtain Hysteresis Loop of the Ferro-Magnetic Material.
5. To understand the principle of thermocouple & to obtain characteristics of different thermocouples.
6. To measure Insulation Resistance &kVAr capacity of power capacitor.
7. To measure Resistivity of High Resistive Alloys.
8. To observe development of tracks due to ageing on different insulating materials e.g. Bakelite, Perspex, polyesters, Mica, Fiberglass etc.
9. Testing of resins and polymers.
10. Measurement of Tangent of Dielectric Loss Angle (tan δ) of solid/liquid dielectric materials.
11. Measurement of Flux Density by Gauss-meter.

Industrial Visit: Minimum one visit should be arranged to an industry related to manufacturing of batteries, capacitors, cables, transformers (Any one industry). A hand written report should be submitted by every student as a part of term work.

Text Books:

[T1] S. P. Seth, "A Course in Electrical Engineering Materials", DhanpatRai and Sons publication.

[T2] "Electrical Engineering Materials", T.T.T.I, Madras.

[T3] K. B. Raina& S. K. Bhattacharya, "Electrical Engineering Materials", S. K. Kataria& Sons.

[T4] P.K. Palanisamy, "Material Science for Electrical Engineering", SciTech Pub. (India) Pvt. Ltd., Chennai.

[T5] Charles P. Poole, Jr. Frank & J. Ownes, "Introduction to Nanotechnology", Wiley Student Edition.

[T6] Ronald M. Dell and David A.J. Rand, "Understanding Batteries", Royal Society of Chemistry, 2001 Publication.

Reference Books:

[R1] D. M. Tagare, "Electrical Power Capacitors-Design & Manufacture", Tata McGraw Hill Publication.

[R2] S. P. Chalotra& B. K. Bhatt, "Electrical Engineering Materials", Khanna Publishers, Nath Market.

[R3] C. S. Indulkar& S. Thiruvengadam, "Electrical Engineering Materials", S. Chand & Com. Ltd.

[R4] Kamraju& Naidu, "High Voltage Engineering", Tata McGraw Hill Publication.

[R5] James F. Shackelford & M. K. Muralidhara, "Introduction to Material Science for Engineering", Sixth Edition by Pearson Education.

[R6] "Insulation Technology Course Material of IEEMA Ratner", Pearson Education.

[R7] Traugott Fischer, "Materials Science for Engineering Students", Elsevier publications.

[R8] Rakosh Das Begamudre, "Energy Conversion Systems", New Age International Publishers.

[R9] David Linden, "Handbook of Battery and Fuel Cells", McGraw Hill, 1984, Publication.

[R10] Chetan Singh Solanki, "Solar Photovoltaic: Fundamentals, Technologies and Applications", Prentice Hall of India Publication.

[R11] R. P. Deshpande, "Ultra capacitors – future of energy storage", McGraw Hill, Publication.

[R12] Linden and Reddy, "Handbook of Batteries", New York McGraw Hill, 2002, Publication.

[R13] R. P. Khare, "Fiber optics and Optoelectronics", Oxford University publication.

Unit	Text Books	Reference Books
1	T1, T3	R1, R3, R8, R10, R13
2	T1, T4	R1, R3
3	T1, T2	R2, R3, R5
4	T1, T2	R1, R3, R6
5	T5, T6	R7, R9, R11, R12
6	T1	R4