CODE	COURSE NAME	CATEGORY	L	T	P	CREDIT
EET362	MATERIAL SCIENCE	PEC	2	1	0	3

Preamble: This course introduces different types of materials used in electrical engineering such as conductors, semiconductors, insulators, solar energy materials, biomaterials, nanomaterials, superconducting materials and magnetic materials. Also, this gives a detailed explanation on dielectrics, polarisation, modern techniques in material science and their applications.

Prerequisite : Basic Electrical Engineering, Basic Electronics Engineering

Course Outcomes : After the completion of the course, the student will be able to:

CO 1	Describe the characteristics of conductor, semiconductor and solar energy materials.
CO 2	Classify different insulating materials and describe polarisation in dielectrics.
CO 3	Explain the mechanisms of breakdown in solids, liquids and gases.
CO 4	Classify and describe magnetic materials and superconducting materials.
CO 5	Explain the recent developments in materials science, modern techniques and their applications in important walks of life.

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO 1	3	-	1	-	-	-	2	-	-	-	-	-
CO 2	3	-	1	-	-	-	-	-	-	-	-	-
CO 3	3	-	1	-	-	-	1	-	-	-	-	-
CO 4	3	-	-	-	-	-	-	-	-	-	-	-
CO 5	3	-	-	-	2	2	2	-	-	-	-	2

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		End Semester Examination
	1	2	
Remember	15	15	30
Understand	35	35	70
Apply			
Analyse			
Evaluate			
Create			

End Semester Examination Pattern : There will be two parts; Part A and Part B. Part A contains 10 questions (each carrying 3 marks) with 2 questions from each module. Students

should answer all questions. Part B contains 2 questions from each module, out of which students should answer any one. Each question can have maximum 2 sub-divisions and carries 14 marks.

Course Level Assessment Questions

Course Outcome 1 (CO1):

1. Describe the dependence of conductivity of conductor materials on temperature and composition.
2. Compare the properties of compound, amorphous and organic semiconductors.
3. Differentiate between intrinsic and extrinsic semiconductors.
4. Derive the expression for conductivity.
5. Write notes on organic solar cell.
6. Explain the different solar selective coatings.
7. What are the different materials used for manufacturing solar cells?

Course Outcome 2 (CO2):

1. Derive Clausius – Mosotti Relation.
2. Explain with examples the different types of polarisation in dielectrics.
3. Classify insulating materials based on their temperature withstanding capability.
4. Explain in detail the properties and applications of SF6 gas.
5. Write short notes on Ferro electricity.
6. Describe the different capacitor materials used in various applications.

Course Outcome 3(CO3):

1. Explain the current voltage characteristics in Townsend's mechanism.
2. Explain the breakdown criteria in Townsend's mechanism.
3. Write notes on streamer mechanism of breakdown in gaseous dielectrics.
4. Explain any one mechanism of breakdown in vacuum insulation.
5. Describe with necessary diagram the treatment of transformer oil.
6. With the help of a circuit diagram, explain the testing of transformer oil.
7. Compare the suspended particle theory and bubble theory mechanisms of breakdown in liquid dielectrics.
8. Write short notes on any one mechanisms of breakdown in solid dielectrics.

Course Outcome 4 (CO4):

1. How are magnetic materials classified?
2. Differentiate between soft and hard magnetic materials.
3. Explain Curie – Weiss law.

4. Write short notes on Ferrites.
5. Define Superconductivity. Explain the characteristics of superconductors.
6. Differentiate between type I and type II superconductors.

Course Outcome 5 (CO5):

1. Compare the top-down and bottom-up growth techniques of nanomaterials.
2. Mention the names of any three non-lithographic growth techniques.Explain any one in detail.
3. Write short notes on Scanning Probe Microscopy.
4. What is a transmission electron microscope?
5. Write a short note on Carbon nanotube.
6. What are the applications of biomaterials?

Model Question paper

QP CODE:

PAGES:2

Reg. No:_____
Name:_____

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY
SIXTH SEMESTER B.TECH DEGREE EXAMINATION, MONTH & YEAR

Course Code: EET 362

Course Name: MATERIAL SCIENCE

Max. Marks: 100 Duration: 3 Hours

PART A (3 x 10 = 30 Marks)

Answer all Questions. Each question carries 3 Marks

1. What are the different materials used for manufacturing solar cells?
2. What is an organic solar cell? Explain.
3. Explain the concept of Ferro-electricity.
4. Mention the different types of polarisation in dielectrics.
5. What is treeing and tracking? Explain.
6. Draw the current-voltage characteristics in Townsend's mechanism.
7. How are magnetic materials classified?
8. Why do certain materials exhibit superconductivity?
9. Write a short note on Carbon nanotube.
10. What are the applications of biomaterials?

PART B (14 x 5 = 70 Marks)
Answer any one full question from each module. Each question carries 14 Marks

Module 1

11. a) What is the effect of alloying of metals in their conduction? Illustrate with an example. **(5)**

    b) Compare the properties of compound, amorphous and organic semiconductors. **(9)**

12. a) Derive the expression for conductivity. Describe the dependence of conductivity of conductor materials on temperature and composition. **(9)**

    b) What is intrinsic breakdown? **(5)**

Module 2

13. a)Derive Clausius-Mosotti relation. **(7)**
    b)Classify insulating materials based on their temperature withstanding capability. **(7)**
14. a) Explain in detail the properties and applications of SF6 gas. **(4)**

    b) Describe the different capacitor materials used in various applications. **(10)**

Module 3

15. a)Compare the suspended particle theory and bubble theory mechanisms of breakdown in liquid dielectrics. **(10)**
    b) List out the breakdown criteria in Townsend's mechanism. **(4)**
16. a) What is meant by transformer oil testing? Why is it done? Explain the tests on transformer oil. **(9)**

    b) Elucidate any one mechanism of breakdown in vacuum. **(5)**

Module 4

17. a) Discuss the application of magnetic materials used in electrical machines, instruments and relays. Justify with reasons. **(10)**

    b) Write short notes on Ferrites. **(4)**

18. a) What do you mean by superconductivity? Explain the characteristics and properties of superconducting materials. **(8)**
    b) What are type I and type II superconductors? **(6)**

Module 5

19. a) Compare the top-down and bottom-up growth techniques of nanomaterials. **(8)**

    b) Write short notes on Scanning Probe Microscopy. **(6)**

20. a) Mention the names of any three nonlithographic growth techniques. Explain any one in detail. **(8)**

b) What is a transmission electron microscope? **(6)**

Syllabus

Module 1

Conducting Materials: Conductivity- dependence ontemperature and composition – Materials for electricalapplications such as resistance, machines, solders etc.

Semiconductor Materials: Concept, materials and properties– Basic ideas of Compound semiconductors, amorphous andorganic semiconductors- applications.

Solar Energy Materials: Solar selective coatings for enhanced solar thermal energy collection. Solar cells -Silicon, Cadmium sulphide and Gallium arsenic – Organic solar cells.

Module 2

Dielectrics: Introduction to Dielectric polarization andclassification–Clausius-Mosotti relation.

Insulating materials and classification- properties- Common insulating materials used in electrical apparatus-Inorganic, organic, liquid and gaseous insulators- capacitor materials.

Electro-negative gases- properties and applications of SF6 gas and its mixtures with nitrogen Ferro electricity.

Module 3

Dielectric Breakdown: Mechanism of breakdown in gases, liquids and solids –basic theories including Townsend's criterion, Streamer mechanism.

Mechanism of breakdown in liquids and solids - suspended particle theory, Bubble theory, Stressed oil Volume Theory, intrinsic breakdown, electro-mechanical breakdown, Thermal breakdown, Treeing and Tracking.

Application of vacuum insulation- Breakdown in high vacuum.
Basics of treatment and testing of transformer oil.

Module 4

Magnetic Materials: Classification of magnetic materials -Curie-Weiss law-Application of iron and its alloys- Hard and soft magnetic materials– Ferrites- Magnetic materials used in electrical apparatus.

Superconductor Materials:-Basic Concept- types, characteristics- applications.

Module 5

Novel materials: Introduction to Biomaterials, Nano-materials and their significance. Growth techniques of nano-materials – Top-down and Bottom-up techniques, Lithographic and Non-lithographic processes (qualitative study only), Characterisation tools of nanomaterials – SPM, AFM, SEM and TEM (qualitative study only), Special topics in nanotechnology – nanostructures of carbon, nanoelectronics, nanobiometrics(qualitative study only).

Text Books

1. Dekker A.J.: Electrical Engineering Materials, Prentice Hall of India.
2. G.K.Mithal: Electrical Engineering Material Science. Khanna Publishers.
3. K.K. Chattopadhyay, A. N. Banerjee: Introduction to nanoscience and nanotechnology, PHI Learning Pvt. Ltd.

Reference Books

1. Naidu M. S. and V. Kamaraju, *High Voltage Engineering*, Tata McGraw Hill, 2004
2. Indulkar O.S.&Thiruvegadam S., An Introduction to Electrical Engineering Materials, S.Chand.
3. Joon Bu Park, Biomaterials Science and Engineering, Plenum Press, New York, 1984

Course Contents and Lecture Schedule

Sl. No.	Topic	No. of Lectures
1	**Conducting Materials, Dielectrics, Semiconductors (8 hours)**	
1.1	Conducting Materials: Conductivity	1
1.2	Dependence ontemperature and composition – Materials for electricalapplications such as resistance, machines, solders etc	2
1.3	Semiconductor Materials: Concept, materials and properties	2
1.4	Basic ideas of Compound semiconductors, amorphous andorganic semiconductors- applications.	1
1.5	Solar Energy Materials: Solar selective coatings for enhanced solar thermal energy collection.	1
1.6	Solar cells -Silicon, Cadmium sulphide and Gallium arsenic – Organic solar cells.	1
2	**Insulating materials(8 hours)**	
2.1	Dielectrics: Introduction to Dielectric polarization and classification.	1
2.2	Clausius- Mosotti relation.	1

2.3	Insulating materials and classification- properties	2
2.4	Common insulating materials used in electrical apparatus- Inorganic,organic, liquid and gaseous insulators- capacitor materials.	1
2.5	Electro-negative gases- properties and applications of SF6 gas and its mixtures with nitrogen.	2
2.6	Ferro electricity	1
3	**Dielectric Breakdown(8 hours)**	
3.1	Mechanism of breakdown in gases– Townsend's criterion	2
3.2	Streamer theory	1
3.3	Mechanism of breakdown in liquids - suspended particle theory, Bubble theory, Stressed oil Volume Theory.	1
3.4	Mechanism of breakdown in solids - intrinsic breakdown, electro-mechanical breakdown, Thermal breakdown, Treeing and Tracking.	1
3.5	Application of vacuum insulation- Breakdown in high vacuum.	1
3.6	Basics of treatment and testing of transformer oil	2
4	**Magnetic Materials, Superconductors, Solar Energy materials (5 hours)**	
4.1	Magnetic Materials: Classification of magnetic materials –Curie-Weiss law	1
4.2	Application of iron and its alloys- Hard and soft magnetic materials– Ferrites- Magnetic materials used in electrical apparatus.	2
4.3	Superconductor Materials:-Basic Concept- types, characteristics-applications.	2
5	**Novel materials(7 hours)**	
5.1	Introduction to biomaterials, nanomaterials and their significance	2
5.2	Growth techniques of nano materials-Top-down and Bottom-up techniques, Lithographic and Non-lithographic processes	2
5.3	Characterisation tools of nanomaterials – SPM, AFM, SEM and TEM	2
5.4	Special topics in nanotechnology – nanostructures of carbon, nanoelectronics, nanobiometrics	1