**ADVANCE MATERIALS SCIENCE**

The course will give insight about the importance of materials( metals ,polymer ,composite ,glasses ) in the engineering application with physical and chemical description of the materials. The students would be taught about the crystallography and imperfections. An exposure to Iron-carbon phase diagram, ferrous materials, heat treatment process, various ferrous and non-ferrous alloys and their application. Familiarity on magnetic, electric properties. An overview of application and processes of ceramics, plastics and other material in the field of Engineering will also be provided. The student would also be able to understand the various destructive testing methods for materials, examination of the microstructure of the engineering materials.

**Course Objective**

The aims of the course is to give fundamental knowledge about type of materials, their usage, properties and characteristics, which are important in engineering design. It is also aimed to give a theoretical background about the analysis of behavior of engineering materials by emphasizing important relationships between internal structure and properties. It attempts to present ways of modifying and control the material microstructures and especially mechanical properties (toughness, strength, fatigue and creep resistance) by suitable heat treatment operation.

**Reference Books**

1- William F. Smith, Foundations of Materials Science and Engineering, 3rd Ed., McGraw-Hill, 2004.

2- James F. Shackelford, Introduction to Materials Science for Engineers, 5th Ed., Prentice Hall, 2000.

3- Larry D. Horath, Fundamentals of Material Science, 3rd Ed., Prentice Hall, 2006

4-material science ,S.L.KAKANI and AMIT KAKANI ,2004 .

5-The science and design of engineering material ,Schaffer ,and Saxena ,1994 .

6-The science and engineering of materials ,Donald .R.Askeland , Phule .2006

7-Engineering materials technology ,James A.jacobs and Kilduff .2005 .

8-Materai science and engineering hand book ,James and Alexander,2001-----------

9-Introduction to Eng. Materials byV.B JOHN 19831. Van Vlash “ Elements of Material Science & Engineering”, John Wiley & Sons.

10-Lakhtin, Y. (Moskow). “Engineering Physical Metallurgy” Foreign Languages Publishing House

11-Narula - Material Science, TMH

12-Srivastava, Srinivasan “ Science of Materials Engineering” New age.

13-. K.M. Gupta “ Material Science”.

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**CONTENTS-**

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**Introduction**

Study of engineering materials is intended to provide the student with an understanding of the nature of materials and their property–structure relationships. In addition, it provides an appreciation of the various mechanisms for modifying materials with respect to both properties and form, and an insight into the use of materials in the built environment and how this has changed.

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| **Study topics** | **Suggested subject matter** |
| **1. Materials classification** | Classification of engineering materials — metals, polymers, ceramics, composites and organics. Elements, compounds and mixtures. Ferrous and non ferrous alloys  Atomic and molecular bonding. Crystalline structures. Macro and micro structures. Primary and secondary bonds |
| **2. Materials properties** | Physical properties — conductivity, melting point, colour, lustre, density  Mechanical properties — tensile and compressive strength, elasticity, hardness, ductility, malleability, toughness, creep and shear strength, fatigue, failure  Deformation — elastic, plastic, slip, twinning and work hardening  Properties testing — hardness, impact, fatigue, torsion and non- destructive testing  Properties analysis — plotting and calculations, Young’s modulus, stress/strain diagrams for steel, aluminium alloys, copper alloys, polymers, ceramics and composites |

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| **3. Metals** | Structure and properties — close packed crystalline structures and related physical and mechanical properties. Dendrites and cast grain structures. Alloying and phases. Cooling curves and phase diagrams. Iron-carbon phase diagram. Solubilities of alloy systems. Steel alloys and uses. Transformation of phases  Production techniques — casting, welding, rolling, extrusion, forging, drawing, spinning, machining, powder metallurgy and welding. Heat treatments such as annealing, tempering and hardening. Recrystallisation. Cold working, hot working and work hardening  Introduction to corrosion. Nonferrous metals and alloys  Industrial and engineering applications of metals |
| **4. Ceramics** | Structure and properties — molecular structure and related physical and mechanical properties. Clay bodies, cements, glass-bonded ceramics, semiconductors, industrial ceramics and bioceramics  Production techniques — slip casting, shell casting, pressing and sintering  Degradation of ceramics — mechanical degradation due to low fracture toughness and wear abrasion  Industrial and engineering applications — insulators, semiconductors, abrasives, optics, refractories in electrical, biomedical and aerospace industries |
| **5. Polymers** | Structure and properties — linear and network structures of organic and inorganic polymers, related physical and mechanical properties. Bioplastics  Production techniques — injection, compression, transfer moulding, laminating and reinforcing, fabrication  Degradation of polymers — fatigue, ultraviolet radiation, thermal, mechanical and chemical degradation. Biodegradable plastics  Industrial and engineering applications — coatings (e.g. Teflon), films, packaging |
| **6. Composites** | Structure and properties — physical and mechanical properties  Cermets. Engineered woods. Fibre production, influence of length, orientation and concentration  Ceramic composites, concrete, glass fibre, carbon fibre and aramid fibre composites  Industrial and engineering applications — fibre reinforced plastics  (e.g. Kevlar), dental, marine, aerospace and military |