**Principles of advanced materials for Design**

*This Course is mainly focused on the principles and applications of various engineering advanced materials and gives an exposure to students for selection of materials for specific applications during the design process. The course also exposes the environmental effects on material life and eco attributes of materials.*

Course Objectives:

1. To expose the role of material properties in the mechanical engineering design process.
2. To explain the selection strategy of the materials
3. To make understand the principles of different advanced materials
4. To give exposure the application of different materials

UNIT I : Introduction to material selection, Role of materials, Classification and properties, Basic Material selection, material property charts- Modulus-density, Strength – density, Modulus- strength, specific stiffness–specific strength, fracture toughness–modulus chart, fracture toughness–strength chart, Friction and wear

The Selection Strategy: Material attributes Selection Translation. Screening: Attribute limits, Ranking: Material indices, Selection Procedure. Computer-Aided Selection.

**Learning outcomes :** At the end of this unit the student should be able to

* understand the role of material Property charts in the process of design.
* select materials for specific applications

UNIT II : Polymers and Elastomers: General Properties of plastics, polymers and elastomers; visco-elastic properties; short-term and long-term properties of plastics; mathematical modeling of plastic properties; Maxwell, Kelvin-Voigt Models; fatigue and fracture of plastics; selection of plastics based on mechanical properties, degradation due to environment,and wear;

**Learning outcomes** : At the end of this unit the student should be able to

* Present different properties of plastics and elastomers
* select the particular plastic for application

UNIT III: Composite materials: Types, classification Metal matrix composites, Fiber reinforced plastics, Stress, strain analysis of continuous fiber composites, rule of mixtures, and general deformation behavior of laminates, Laminate stress strain relations.

**Learning outcomes** : At the end of this unit the student should be able to

* classify the composite materials
* estimate the laminate stresses in frp composites

UNIT IV: Smart materials: Shape Memory alloys, Shape memory effect, Super elasticity, Constitutive relations , Tanaka’s principle, principles of Piezoelectric materials, properties, actuation of structural components,

MR and ER fluids, Mechanisms and properties and behavior.

**Learning outcomes** : At the end of this unit the student should be able to

* understand the concept of shape Memory effect and super elasticity
* present The constitutive relations of Shape Memory alloys
* understand the principles and applications of different smart materials

UNIT V: Materials and the Environment: The Material Life, Material and Energy-Consuming Systems, The Eco-Attributes of Materials,

**Learning outcomes** : At the end of this unit the student should be able to

* estimate the material life under different environment conditions
* present the Eco attributes of materials

Books:

1. Ashby, M.F., “Materials Selection in Design”, Butterworth-Heinemann, 4/e, 2010.
2. A.V. Srinivasan, “ Smart structures” Cambridge university press
3. Autar K.Kaw, “Mechanics of Composite Materials” Second Edition CRC press.

**Course Outcomes**:

After completion of the course the student able to

1. Understand the importance of the role of different material properties in engineering applications.
2. Select proper materials for a specific application.
3. Present the stress strain relations for different engineering materials.
4. Understand principles of smart materials and their structural applications
5. Predict the life cycle of a material.