MSS 505: COMPOSITE MATERIALS (3 Credits)

Objectives: The objectives of this course is to (i) introduce an engineering technology of mixing the materials for high-performance applications. (ii) explain the basics of composite materials, classification, preparation, properties and applications. (iii) differentiate the composites with monolithic materials in terms of their mechanical and thermal properties. (iv) specify the industrial importance of novel composite materials for aerospace applications.

Expected course outcomes: By the end of this course, students will be able to (i) explain composite materials, classification and preparation methods. (ii) compare the properties of composites with that of monolithic components. (iii) prepare the composite materials for their project and research work and characterize them to solve the problems in the design of new materials for various applications. (iv) have the required skills for industries where materials with high strength coupled with light weight is required, such as aerospace, automotive, space research etc.

Unit I

Introduction –Definition, classification, matrix materials, reinforcing materials, comparison of properties with monolithic materials, applications. Interfaces in composites, contact angle, wetting. Micromechanics of composites – density. Mechanical properties – prediction of elastic constants, Halpin-Tsai equations. Thermal properties – heat capacity, longitudinal and transverse conductivity, thermal expansion coefficient. Mechanism of load transfer from matrix to fiber – (fiber elastic – matrix elastic, fiber elastic- matrix plastic), Micro-Raman spectral analysis. Problems solving.

Strength, fracture and fatigue: tensile strength, compression strength, fracture modes in composite, designing with composite materials. 14 hours

Unit II

Reinforcing materials - fabrication, structure, preparation, and application of boron, glass, carbon, aramid and ceramic fibers. Concrete making materials - structure, composition, properties and applications, special concrete, reinforced and pre-stressed concrete.

Polymer matrix composites- fabrication, structure, interface, properties and applications. Advanced thermoplastic composites and applications. Wood-microstructure, properties, wood-plastic composites, polymer-concrete composites, biopolymer nanocomposites and applications. 14 hours

Unit III

Metal matrix composites- Fabrication, interface, properties and applications. Dispersion strengthened, particle reinforced, fiber reinforced and laminate composites, comparison of properties. Fiber reinforced super alloy composites, Superconducting multifilamentary composites-introduction, types and fabrication.

Ceramic matrix composites – Types, fabrication, interface, properties and applications.

Carbon fiber composites- Fabrication, interface, properties and applications. Advanced C-C composites, C-C composites in aerospace engineering. 14 hours