MTPE4002 ADVANCED ENGINEERING MATERIALS AND PROCESSING (3-0-0)

Course Objective:
To impart knowledge of advanced and emerging engineering materials, their structure–property relationships, and the modern processing techniques employed for their production and application.

Module I (6 Hours)
Advanced ferrous materials: high strength low alloy (HSLA) steels, microalloyed steels; advanced high strength steels for automotive applications – dual phase, TRIP, TWIP and martensitic steels; maraging steels; tool steels; superalloys – Ni-base, Co-base and Fe-base; intermetallics – Ni3Al, TiAl and FeAl, properties and applications.

Module II (6 Hours)
Advanced non-ferrous materials: Al-Li alloys and aerospace aluminium alloys; titanium alloys for aerospace and biomedical applications; magnesium alloys for lightweight structures; shape memory alloys – shape memory effect; metallic glasses – formation, properties and applications; high entropy alloys – concept, core effects and applications.

Module III (6 Hours)
Advanced ceramics and polymers: structural ceramics – alumina, zirconia, SiC and Si3N4; transformation toughening and toughening mechanisms in ceramics; functional ceramics – dielectric, piezoelectric and magnetic ceramics; engineering and high performance polymers; biomaterials – metallic, ceramic and polymeric.

Module IV (6 Hours)
Composites and nanomaterials: classification of composites – MMC, PMC and CMC; reinforcements and matrix materials; processing of composites – stir casting, squeeze casting, powder metallurgy route; nanomaterials – classification, synthesis by top-down and bottom-up approaches, size dependent properties; nanocomposites and their applications.

Module V (6 Hours)
Advanced processing techniques: rapid solidification processing; severe plastic deformation – equal channel angular pressing, thermo-mechanical processing; additive manufacturing of metals – selective laser melting, electron beam melting and directed energy deposition.

Course Outcome:
CO1: To understand the composition, structure and properties of advanced ferrous materials and superalloys.
CO2: To describe the characteristics and applications of advanced non-ferrous alloys, shape memory alloys, metallic glasses and high entropy alloys.
CO3: To explain the behaviour of advanced ceramics, polymers, biomaterials and smart materials.
CO4: To select suitable processing routes for composites and nanomaterials for specific engineering applications.
CO5: To apply advanced processing and surface engineering techniques for the development of high performance components.

Text Books:
1. Smallman R.E. and Ngan A.H.W., Modern Physical Metallurgy and Advanced Materials; Butterworth-Heinemann.
2. Gupta K.M., Engineering Materials: Research, Applications and Advances; CRC Press.

Reference Books:
1. Callister W.D. and Rethwisch D.G., Materials Science and Engineering: An Introduction; Wiley.
2. Chawla K.K., Composite Materials: Science and Engineering; Springer.