6th Semester	RME6D001	Smart and Composite Materials	L-T-P 3-0-0	3 Credits

MODULE I (7 HOURS)

Introduction: definitions and classifications; natural composites; role of matrix and reinforcement; factors which determine properties; the benefits of composites.

Reinforcements and the reinforcement matrix interface: natural fibers; synthetic organic fibers – aramid, polyethylene; and synthetic inorganic fibers – glass, alumina, boron, carbon, silicon based fibers; particulate and whisker reinforcements, reinforcement-matrix interface – wettability, interfacial bonding, methods for measuring bond strength.

MODULE II (8 HOURS)

Metal matrix composites: Introduction, important metallic matrices; metal matrix composite processing: solid state processing – diffusion bonding, powder metallurgy; liquid state processing – melt stirring, compocasting (rheocasting), squeeze casting, liquid infiltration under gas pressure; deposition – spray co-deposition and other deposition techniques like CVD and PVD; in situ processes. Interface reactions. Properties of MMCs – physical properties; mechanical properties like elastic properties, room temperature strength and ductility, properties at elevated temperatures, fatigue resistance. Processing, structure of multifilamentary superconductors, properties of aluminium reinforced with silicon carbide particles

MODULE III (7 HOURS)

Ceramic matrix composites: Introduction; processing and structure of monolithic materials – technical ceramics, glass-ceramics. Processing of ceramics: conventional mixing and pressing – cold pressing and sintering, hot pressing, reaction bonding processes, techniques involving slurries, liquid state processing – matrix transfer moulding, liquid infiltration, sol-gel processing, vapour deposition techniques like CVD, CVI, liquid phase sintering, lanxide process and in situ processes. Processing, properties and applications of alumina matrix composites - SiC whisker reinforced, zirconia toughened alumina; Glass-ceramic matrix composites; Carbon-carbon composites - porous carbon-carbon composites, dense carbon-carbon composites.

MODULE IV (6 HOURS)

Polymer matrix composites: Introduction; polymer matrices – thermosetting, thermoplastic, rubbers. Processing of PMCs: Hand methods – hand lay-up, spray-up methods; Moulding methods – matched die moulding, bag moulding processes (autoclave moulding), resin transfer moulding, pultrusion; Filament winding; Injection moulding. Processing, properties and applications of fibre-reinforced epoxies, PEEK matrix composites, rubber matrix composites. Damping characteristics. Environmental effects in polymer matrix composites. Recycling of PMCs.

MODULE V (8 HOURS)

Sandwich structures, foam core type arrangements; Honey comb structures. Micromechanics of unidirectional composites: micromechanics models for stiffness – longitudinal stiffness, transverse stiffness, shear modulus, poisson's ratio. Micromechanics models for strength – longitudinal tensile strength, longitudinal compressive strength, transverse tensile strength, transverse compressive strength, inplane shear failure, thermal and moisture effects. Short fibre composites: reasons for using short fibre composites, fibre length, fibre orientation, stress and strain distribution at fibres, critical fibre length and average fibre stress, stiffness and strength: stiffness of aligned systems, non-aligned systems and variable fibre orientation, strength of aligned systems, 2-D composites, variable fibre orientation.

Books:

[1] Composite Materials: Engineering and Science, by Matthews and Rawlings, CRC Press.

[2] An Introduction to composite material, by D.Hull and T.W. Clyne, Cambridge University press.

[3] Metal Matrix Composites, Thermomechanical Behaviour by M.Taya, and R.J.Arsenault, Pergamon Press, Oxford.

[4] Fundamentals of Metal Matrix Composites by S.Suresh, A.Martensen, and A.Needleman, Butterworth, Heinemann

[5] Mechanics of composite materials, R. M. Jones, Mc Graw Hill Book Co.

[6] Mechanics of composite materials and structures, M Mukhopadhay, Universities Press.

[7] Fiber-Reinforced composite materials, Manufacturing & Design, P. K. Mallick, Marcel Dekken, Inc. New York & Basel.
[8] F.L. Matthews and R.D. Rawlings, Composite Materials: Engineering and Science, Chapman Hall, London, 1994.
[9] Weinheim, Structure and Properties of Composites, Materials ScienceTechnology, Vol. 13, VCH, Germany, 1993.

Digital learning Resources:

CourseName:	Introduction to Composites
CourseLink:	https://nptel.ac.in/courses/112/104/112104229/
CourseInstructor:	Dr Nachiketa Tiwari, IITKanpur

Course Name:	Processing of nonmetals
Course Link:	https://nptel.ac.in/courses/112/107/112107086/
Course Instructor:	Dr Indradeep Singh, IIT Roorkee