References

1.Composite Materials Engineering & Science – F L Mathews & R D Rawlings (Chapman & Hall, 1990)
2. Composite Materials Science & Engineering – K K Chawla (Springer-Verlag, 1987)
3. Principles of Materials Science & Engineering – William F Smith (McGraw-Hill, 1988)
4. A Text Book of Materials Science & Metallurgy – O P Khanna (Dhanpat Rai pub., 1999)
5. Selection of Engineering Materials – Gladis Lewis (Printice Hall, 1990)
6. Engineering Materials & Their Applications – R A Flinn & P K Trojan (Jaico pub., 1998)
7. Composite Materials – S C Sharma. (Narosa, 2000)
8. An Introduction to Metal Matrix Composites – Clyne T W (Cambridge University, 1995)
9. Advanced Materials Science and Engineering of Carbon – Inagaki Michio (Oxford Tsinghua University Press, 2014)
10. Introduction to Polymer Clay Nanocomposites – Gurses Ahmet (Composites Pan Stanford, 2015)
11. Biopolymer Nanocomposites Processing, Properties and Applications- Dufresne Alain and Sabu Thomas (John Wiley and Sons, 2016).
12. Fiber Reinforced Composites – Mallick P K (CRC Press, 2008)

MSS 506: NANOSCIENCE AND NANOTECHNOLOGY – II (3 Credits)

Objectives: This course (i) deals with advanced concepts in nanoscience and technology, focusing on the properties of metal and semiconductor nanomaterials (ii) emphasises their applications in electronics and optics. (iii) deals special nanomaterials such as fullerenes, carbon nanotubes and nanocomposites are introduced.

Expected course outcomes: Student (i) gains good knowledge of the size dependent properties of nanostructures which make them a unique class of materials. (ii) attains a broad perspective of still newer materials of interest in this category, such as fullerenes and nanotubes.(iii) is encouraged to undertake start-ups in this new field

Unit I

Metal Nanoparticles: Introduction. Optical, Electrical and Magnetic properties. Surface plasmon resonance. GMR and CMR materials. Spintronics Applications of metal nanoparticles.

Semiconductor Nanoparticles: Introduction. Optical properties- Band gap variation with size- Brus equation. Photoluminiscence. Nonlinear optical processes. Applications of semiconductor nanoparticles. 14 hours

Unit II

Fullerenes: Preparation, properties, nanostructured fullerene films, applications. Carbon nanotubes: Introduction- single-walled and multiple–walled nanotubes. Synthesis, purification and structure. Methods of opening and filling nanotubes.

Physical properties. Non-carbon nanotubes. Applications of nanotubes. Biological applications of nanotechnology. Brief idea of nanobiotechnology. 14 hours

Unit III

Nanocomposites: Introduction to composites and nanocomposites. Ceramic, metal, polymer nanocomposites. Thin film and CNT- based nanocomposites. Polymer and rubber based nanoclay composites. Nanoscale fillers - nanofiber or nanotube fillers. Nanotube processing. Inorganic filler/polymer interfaces. Processing of nanocomposites.

Nanocomposites for electrical, optical and magnetic applications. Mechanical properties - modulus and the load- carrying capability of nanofillers - failure stress and strain toughness. Glass transition and relaxation behaviour.

Natural nanocomposite materials - biologically derived synthetic nanocomposites, templating. Natural nano-biocomposites, biomimetic nanocomposites. 14 hours

References:

1. Nanoscale Materials (Ed) - L.M. Liz, Marzan and P V Kamat (Kluwer, 2003)
2. Nanostructured Materials and Nanotechnology (Ed) - H S Nalwa, (Academic, 2002).
3. Introduction to Nanotechnology- C P Poole and F J Owens (Wiley- Intersci., 2006)
4. Nanotechnology and Nanoelectronics - W R Fahrner (Ed) (Springer, 2006)
5. Quantum Dots - L Jacak, P Hawrylak, A Wojs, (Springer, 1997)
6. Physics of Low Dimensional Structures - J H Davis, (Cambridge, 1998)
7. Nanostructured Magnetic Materials and Applications - Shi D et al (Springer, 2002)
8. Nanobiotechnology Concepts, Applications and Perspectives - Niemeyer C
9. Nanocomposite Science & Technology - Pulickal M Ajayan et. al (Wiley-VCH, 2003)
10. Introduction to Nanocomposite Materials - Thomas Twardowski, (DEStech, 2001)
11. Polymer Clay Nanocomposites - T J Pinnavaia, G W Beall, (Wiley, 2004)

MSS 507: CRYSTAL GROWTH (3 Credits)

Objectives: Objective of the course is to provide a fairly detailed knowledge on the various crystal growth processes. In particular, single crystal growths in bulk form and in epitaxial thin film forms which are essential for various research and development/technological applications.

Expected course outcomes: The student should be familiar with the crystal growth techniques with the necessary nucleation-growth theory. Good foundation on these topics would be helpful during their career in research or industry.

Objectives: Crystal growth is a process of growing crystals from a solution or melt, and it is widely used in fields such as including materials science, electronics, semiconductors, optics, and pharmaceuticals industries.Objective of the course is to provide (i) a fairly detailed knowledge on the various crystal growth processes with necessary nucleation-growth theory (ii) single crystal growth techniques in bulk form and in epitaxial thin film forms which are essential for various research and development/technological applications.

Expected course outcomes: The student should (i) be familiar with the theories on the growth of crystals (ii) be familiar with the different crystal growth techniques (iii) be familiar with the different single crystal growth techniques which are very essential for semiconductor industries. (iv) find a career in research or electronic industries.