

Approval: 5th Senate Meeting

Course Name : Bioinspired Materials
Course Number : CY550
Credit : 3-0-0-3
Prerequisites : IC130 and IC241 /or permission from instructor
Students intended for: B.Tech. (all branches), M.Sc., M.Tech., M.S. and Ph.D.
Elective or Compulsory: Elective

Course Description

Bioinspired Materials is an upcoming field, wherein research works explore the use of molecules, methods and concepts of biology/nature to design and create novel materials with new functions and properties suitable for a variety of technological applications. Living organisms have evolved well-adapted structures and materials over geological timescales through natural selection. Humans have always looked at nature for answers to several problems, and nature has solved several engineering problems such as harnessing solar energy, environmental exposure tolerance, self-healing, self-cleaning, self-assembly and wettability, with much greater efficiency than humans. There is a lot to learn from biology/nature. In this course, we will study how we can derive inspiration from biology/nature and effectively mimic the structure and properties in artificial materials and thereby, harness their potential for various technological applications.

Course Contents

Unit 1: Fundamental Principles

08 hours

Biomimicry – introduction; design concepts; typical examples; intelligent life; multiscale hierarchical structures; heterogeneous interfaces; high strength materials; biomimetic strategies and materials processing

Unit 2: Concepts and Processes

12 hours

Bioinspired synthesis of nanostructures; supramolecular chemistry; self-assembly; controlled assembly; biomineralization; stimuli-responsive behavior; self-replication; self-healing; self-cleaning; anti-reflection; anti-fouling; wettability; adhesion; scaffolds; multi-functionality; sensing; transduction; camouflage; swam intelligence; fabrication and replication of biological systems

Unit 3: Technological Applications

12 hours

Artificial photosynthesis; renewable energy; biofuels; photovoltaics; catalysis; ion channels; medical diagnostics; drug delivery; tissue engineering; prosthetics; electronics; photonics; optics; fog harvesting; water filtration; defense; robotics; aeronautics; other new technological applications; review of current research

Unit 4: Investigation Tools

10 hours

High resolution optical microscopy; scanning electron microscopy; transmission electron microscopy; scanning probe microscopies; x-ray absorption spectroscopy; x-ray tomography; x-ray scattering; x-ray photoelectron spectroscopy; time-of flight secondary ion mass spectrometry; neutron scattering; single molecule probes; theoretical modelling and computer simulations

Text books:

[1] L. Jiang, L. Feng, *Bioinspired Intelligent Nanostructured Interfacial Materials*, World Scientific Publishing Company (2010).

[2] S. Mann (Ed.), *Biomimetic Materials Chemistry*, Wiley-VCH (1995).

Further readings:

[1] Y. Zhou, *Bio-Inspired Nanomaterials and Nanotechnology*, Nova Science Publishers Inc. (2009).

[2] C. S. S. R. Kumar (Ed.), *Biomimetic and Bioinspired Nanomaterials*, Wiley-VCH (2010).

[3] Y. Bar-Cohen, *Biomimetics: Biologically Inspired Technologies*, CRC Press (2005).

[4] Youtube Channel: <http://www.youtube.com/functionalsurfaces>