MCYF 406- Advanced and Functional Materials (3-1-0) 4 credits

Module 1 **8 hours**

Dendrimers and dendrimer based multifunctional nanoparticles: Anionic, neutral or cationic terminal functionalities of dendrimers, Divergent and convergent methods of preparation, chemical and biological properties, dendrimers as artificial macromolecules, application in supramolecular chemistry, pharmacokinetic properties and biomedical applications

Module 2 **8 hours**

Advanced Functional Oxide materials: Functional and multifunctional materials, wurtzite, corundum, zircon, scheelite, wolframite, fluorite, spinel, garnet, perovskite, pyrochlore, bixbyite materials, Structure-property relationships, Tuning the properties using the variations in composition, temperature, pressure, strain, external fields, defect kind and density (vacancies), film orientation and nanoparticle size. Applications: Energy related materials, energy storage, dielectrics, ferroelectrics, piezoelectrics, superconductors, magnetic and spintronic materials.

Module 3 **10 hours**

Biodegradable and smart polymers: Difference between biopolymers and biodegradable polymers, Sugar-based, Starch based and Cellulose-based biopolymers, Classification of biodegradable polymers, polymers with ester amide and ether functional groups. Quality and sustainability related issues associated with biopolymers for food packaging applications, Types of smart polymers, temperature, pH, photo responsive, enzyme responsive and inflammation responsive polymers, Dual +and multi-stimuli responsive polymers for biomedical applications, smart polymer gels properties and their applications

Module 4 **8 hours**

Renewable resources for functional polymers: Natural polymer resources, Cellulose and its erivatives for medical use, Biomedical application of starch and its derived products, Alginates – properties and applications, pectins, hyaluronate properties and protein binding, Chitin and chitosan for drug delivery, beta-glucans, microbial polyesters, glycoproteins for biomaterial applications.

Module 5 **8 hours**

Electrochemical materials and sensors: Electrochemical materials for energy storage, Materials for negative electrodes, Ionic liquid materials, Electrochemical challenges, Electrochemical capacitors (ECs), Characteristics of electrode materials, Carbon- based materials, transition metal oxides and conducting polymers, composite of pseudocapacitive and carbonaceous materials for ECs, electrochemical probes, sensing applications, graphene-oxide based materials as platforms for sensing heavy metals, screen-printed electrochemical sensing platforms.

References

• Supramolecular chemistry, Jonathan W. Steed and Jerry L. Atwood, Wiley 2nd ed, 2017
• Maria Rosa Aguilar and Julio San Roman, "Smart Polymers and Their Applications": Second Edition, Woodhead/ Elsevier Publication, UK, 2019
• Peter A. Williams, "Renewable resources for functional polymers and biomaterials", RSC, 2011.
• William Wagner, Shelly Sakiyama-Elbert, Guigen Zhang, Michael Yaszemski (Eds), Biomaterials Science – An introduction to materials in medicine, Elsevier, 2020
• Sujata V. Bhat. Biomaterials, Narosa Publishing house, 2002.
• Walfried Plieth, "Electrochemistry for Materials Science" First Edition, Elsevier Publication, Netherland, 2007

Further Reading

• V. Balzani, A. Credi, M.Venturi, "Molecular Devices and Machines: A Journey into the Nanoworld", Wiley-VCH Publication, Italy, 2003.
• F, W. Billmayer, JR. " A Text Book of Polymer Science" A Wiley-lnterscience Publication, New York, 1984
• Dong-Sing Wuu, "Functional Oxide Based Thin-Film Materials" MDPI Publication, Switzerland, 2020.
• Masoud Mozafari, Narendra Pal Singh Chauhan, "Advanced Functional Polymers for Biomedical Applications", Elsevier, 2019