UNIVERSITY OF MADRAS

B.Sc. DEGREE PROGRAMME IN CHEMISTRY

SYLLABUS WITH EFFECT FROM 2023-2024

<table>
<tr><td>Title of the Course</td><td colspan="7">NANOSCIENCE</td></tr>
<tr><td>Paper No.</td><td colspan="7">E C- V (EC-5)</td></tr>
<tr><td>Category</td><td>Elective</td><td>Year
Semester</td><td>III
V</td><td>Credits</td><td>2</td><td>Course Code</td><td>324E5A</td></tr>
<tr><td>Instructional hours per week</td><td>Lecture</td><td>Tutorial</td><td colspan="2">Lab Practice</td><td colspan="3">Total</td></tr>
<tr><td></td><td>4</td><td></td><td colspan="2">-</td><td colspan="3">4</td></tr>
<tr><td>Prerequisites</td><td colspan="7">Basics knowledge in physics and chemistry</td></tr>
<tr><td>Objectives of the course</td><td colspan="7">This course aims at providing knowledge on
• introduction to nanoparticles/clusters and nanocomposites
• properties of nanomaterials
• characterization of nanomaterials by different methods
• synthesis of carbon nanotubes, graphene, quantum dots, self-assembled nanomaterials
• applications of nanomaterials as sensors</td></tr>
<tr><td>Course Outline</td><td colspan="7">UNIT I
Introduction to nanoscience
Definition of terms – nanoscience, nanoparticles, clusters, quantum dots, nanostructures and nanocomposites. Electron behaviour in free space, bulk material and nanomaterials.
Synthesis and stabilization of nanomaterials Top-down approach (physical methods), mechanical dispersion – ball milling, methods based on evaporation of a precursor-inert gas condensation, ion sputtering, spray pyrolysis, aerosol synthesis-nanolithography. Bottom–up approach (chemical methods) - solvothermal synthesis, photochemical method, gamma radiolysis, sonochemical synthesis, electro deposition, sol-gel method, nanomaterials via chemical routes- solvents reducing agents, capping agents-stabilization of nanoparticles -electrostatic and steric stabilization, common stabilizers, nanoparticle growth in solution, templated growth, Langmuir – Blodgett (L-B) method, reverse micelles-emulsion method.</td></tr>
<tr><td></td><td colspan="7">Unit II
Properties of materials on a nanoscale
Optical properties of metal and semiconductor nanomaterials- surface Plasmon resonance (SPR), surface enhanced Raman spectra (SERS), quantum confinement effect, tuning of optical spectrum. Magnetic properties - Fe_3O_4 particle, supra magnetic properties, electronic properties, Chemical properties – chemical process on the surface of nanoparticles, catalysis, mechanical properties.</td></tr>
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	UNIT III **Techniques employed for characterisation of nanomaterials** Spectroscopy – UV-visible, Photoelectron spectroscopy – Electron microscopy – Scanning Electron Microscopy (SEM), Transmission Electron Microscopy (TEM), Scanning probe microscopy (SPM) – Atomic Force Microscopy (AFM), Scanning Tunneling Microscopy (STM), Optical microscopy – confocal microscopy, X-ray diffraction (XRD) [Principle and Block diagram only].
	UNIT IV **Special nanomaterials** Carbon Nano Structures Carbon nanotubes: Introduction - types - zigzag, armchair, helical, synthesis by CVD, Functionalization of Carbon Nanotubes, Reactivity of Carbon Nanotubes, Field emission, Fuel Cells, Display devices. Other Important Carbon-based materials: Preparation and Characterization Fullerene, Graphene, properties, DLC and nanodiamonds and Applications Semiconductor nanoparticles: Quantum dots, synthesis – chemical synthesis using clusters, properties, porous silicon – electrochemical etching, aerogel – types – silica aerogel, resorcinol formaldehyde (RF) aerogels, zeolites –applications. Self-Assembled Nanomaterials: Self Assembled Monolayers (SAMS) – inorganic, organic molecules.
	UNIT V **Application of nanomaterials** Biomedical Applications- drug, drug delivery, biolabelling, artificial implants, cancer treatment. Sensors – Natural nanoscale sensors, chemical sensors, biosensors, electronic noses. Optics & Electronics – Nanomaterials in the next generation computer technology, high-definition TV, flat panel displays, quantum dot laser, single electron transistors [SET]. Nanotechnology in agriculture – Fertilizer and pesticides nanomaterials for water purification, nanomaterials in food and packaging materials, fabric industry. Impacts of Nanotechnology – human & environmental safety risks.
Extended Professional Component (is a part of internal component only, Not to be included in the external examination question paper)	Questions related to the above topics, from various competitive examinations UPSC/ JAM /TNPSC others to be solved (To be discussed during the Tutorial hours) Knowledge, Problem solving, Analytical ability, Professional Competency, Professional Communication and Transferable skills.
Skills acquired from this course	

Recommended Text	1. Sulabha K. Kulkarni, *Nanotechnology: Principles and Practices*, Capital Publishing Co., NewDelhi. 2. Pradeep. T, *Nano: The Essentials, Understanding Nanoscience and Nanotechnology*; Tata McGraw-Hill Publishing Company Limited, NewDelhi,2007. 3. Shah. M.A.; Tokeer Ahmad, *Principles of Nanoscience and Nanotechnology*; Narosa Publishing House, New Delhi,2010. 4. Murthy. B.S; Shankar. P, Baldev Raj.; Rath. B.B. James Murday, *Textbook of Nanoscience and Nanotechnology*; Universities press, India Ltd, Hyderabad.2012.
Reference Books	1. Sharma. P.K., *Understanding Nanotechnology*; Vista International Publishing House, Delhi.2008. 2. Charles P. Poole Jr.; Frank J. Owens. *Introduction to Nanotechnology;* A John Wiley & Sons, INC., Publication,2003. 3. Viswanathan B., *Nano Materials;* Narosa Publishing House, New Delhi,2009. 4. Edited by C.N.R. Rao; Muller .A; Cheetham, A. K. *Nanomaterials Chemistry Recent Developments and New Directions*, WILEY-VCH Verlag GMBH & Co.,K Ga A, Darmstad. 5. Jing Zhong Zhang, *Optical properties and spectroscopy of Nanomaterials*; World Scientific Publishing Pvt. Ltd., Singapore.
Website and e-learning source	1) http://www.nanotechnology.com/docs/wtd015798.pdf 2) http://nccr.iitm.ac.in/Nanomaterials.pdf

Course Learning Outcomes (for Mapping with POs and PSOs) On completion of the course the students should be able to

CO1: explain the general concepts and physical phenomena of relevance within the field of nanoscience.

CO2: describe the properties, synthesis, characteristics of nanomaterials, special nanomaterials and applications.

CO3: examine the structure, properties, applicability and characterization of nanomaterials.

CO4:analyze various synthesis procedures, characterizations and uses of carbon nanotubes, fullerene and graphene

CO5: discuss applications of nanomaterials of sensors and in optics and electronics

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	S	S	S	S	S	S	M	S	M
CO2	M	S	S	S	M	S	S	M	M	M
CO3	S	S	S	M	S	S	S	M	S	M
CO4	S	S	S	S	S	S	S	M	M	M
CO5	S	M	S	S	S	S	S	M	M	S

CO-PO Mapping (Course Articulation Matrix)

CO /PO	PO1	PO2	PO3	PO4	PO5
CO1	3	3	3	3	3
CO2	3	3	3	3	3
CO3	3	3	3	3	3
CO4	3	3	3	3	3
CO5	3	3	3	3	3
Weightage	15	15	15	15	15
Weighted percentage of Course Contribution to POs	3.0	3.0	3.0	3.0	3.0

Level of Correlation between PO's and CO's