THE COCHIN COLLEGE

Koovapadam, Kochi-2

Affiliated To Mahatma Gandhi University
Re-accredited by NAAC With B+ Grade

Fourth Cycle
NAAC Accreditation 2024

Criterion 1
Curricular Aspects

1.3 - Curriculum Enrichment

Metric No. 1.3.1

Institution integrates crosscutting issues relevant to Professional Ethics, Gender, Human Values, Environment and Sustainability in transacting the Curriculum.

PhD Coursework Syllabus Addressing Environment and Sustainability

Submitted to

National Assessment and Accreditation Council

Digitally signed by
Mrudula Menon V.
Principal-in-charge
The Cochin College, Kochi-2

Phone: 0484 2224954, 2226449

THE COCHIN COLLEGE

KOCHI - 682 002

(Affiliated to Mahatma Gandhi University and Accredited by NAAC)

Website: www.thecochincollege.edu.in

email: email@thecochincollege.edu.in

SYLLABUS OF COURSE WORK PAPER III - NANOSTRUCTURES AND MATERIALS CHARACTERISATION

Total Credits: 4

Total Hours: 75

Name of the Candidate: Dhanya Raj

Discipline: PHYSICS

Title of Research work: Study on the effect of structural and optical properties of $BaTiO_3$ nanoparticles (BTNP) and its applications.

Number and date of the Registration order: 3592/AC A 11/2022/MGU dated 07-04-2022;

Registration No: 128/2021

Name of the Research Supervising Teacher: Dr. Manjusha M V

Name of the Research Centre: The Cochin College

UNIT 1

Nanostructures: Synthesis and properties [20 h]

Applications of Schrodinger equation in nanoworld: particle confined in one dimension, quantum leak, penetration of barrier, nanostructures for electronics quantum dots, nanowires, superlattices and heterostructures Preparation of quantum nanostructures, size and dimensionality effects, single electron tunnelling. Metal nanoclusters, semiconducting nanoparticles, rare gas and molecular clusters. Self-assembly and catalysis, Synthesis routes: bottom-up approaches- PVD, CVD, MBE, PLD, wet chemical; top-down synthesis routes- mechanical alloying, nanolithography.

UNIT II

Nanomaterials and applications [15 h]

Carbon nanostructures: carbon clusters, fullerenes, CNTs- fabrication, properties and applications, 2-D nanostructure- graphene , Nanostructured materials: superparamagnetic nanoparticles, GMR, ferrofluids, colossal magnetoresistance, nanostructured thermal devices, superhydrophobic nanostructured surfaces, biomimetics; nanomachines and nanodevices- MEMs, NEMs, nano sensors, molecular and supramolecular switches, nano catalysts, properties and applications of nano ZnO and TiO2, dendrimers, micelles

UNIT III

Optical Absorption spectroscopy [10 h]

Instruments for absorption photometry – radiation sources, wavelength selection, cells and sampling devices, detectors; Fundamental laws of photometry (Beer Lambert's law), spectrophotometric accuracy, precision, absorptivity, bathochromic and hypsochromic shift, Jablonski diagram, Principles of Fourier transform optical measurements- advantages of Fourier transform spectrometry, time domain

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spectrometry, fourier transform of interferograms. Optical atomic spectra- atomic line widths, effect of temperature.

UNIT IV

Optical Emission spectroscopy [10 h]

Principles and applications of Differential, difference and derivative spectroscopy, photoacoustic and thermal lens spectroscopy; General applications of uv absorption spectroscopy. Theory of fluorescence and phosphorescence spectrophotometry, PL power, total luminescence spectroscopy, fluorescence lifetime measurements, quenching and applications, principle and applications of chemiluminescence, Qualitative ideas of resonance Raman spectroscopy, surface enhanced raman spectroscopy

UNIT V

Chemical, thermal and X-ray diffraction methods [20 h]

X ray diffraction- production and detection of X-rays and X-ray spectra, Moseley's law, Geometry of an X-ray diffractometer, X-ray photoelectron spectroscopy, X-ray fluorescence, Particle size determination, Debye Scherrer formula, stress measurement. Auger recombination, Auger Emission Spectroscopy, Working of SEM, TEM, AFM and STM with instrumentation, Mass spectrometry: ionization methods, mass spectrometers and analyzers, correlation of mass spectra with molecular structure. Thermal methods: thermogravimetry, DTA, DTG, DSC, microthermal analysis; Principles of pH measurement, potentiometry, voltammetry and electrogravimetry

COMPULSORY ASSIGNMENTS

Preparation of a report on the basis of a proposed work in the synopsis detaling

1. Review of previous work done in the field.
2. Scope of the proposed work
3. Procedure to be adopted for the synthesis, characterization and property studies
4. Possible outcomes of the proposed work

Recommended Text Books: (Unit 1 & 2)

1. Introduction to nanotechnology: Charles P Poole, Frank J Owens-Wiley india

2. Textbook of nanoscience and nanotechnology- B S Murty, P Shankar, Baldev Raj, B B Rath, James Muday- Springer Univ. Press

3. Introduction to nanoscience and nanotechnology- KK Chattopadhyay and A N Banerjee-PHI

4. Introduction to Nanoscience- S M Lindsay, Oxford University Press.

Recommended Text Books: (Unit 3,4 & 5)

1. Instrumental methods of analysis- Williard, Merritt, Dean, Settle- CBS 2. Introduction to nanoscience and nanotechnology- KK Chattopadhyay and A N Banerjee-PHI

3. Introduction to Nanoscience- S M Lindsay, Oxford University Press. 4. Principles of Instrumental analysis- Holler, Skoog, Crouch-Cenage

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Recommended references:

1. Instrumental methods of chemical analysis-Chatwal, Anand- Himalaya 2. Instrumental methods of chemical analysis- Galen W Ewing-MGH 3. X ray diffraction a practical approach :C Suryanarayana, M Grant Norton; Springer

2. Nanophotonics- Paras N Prasad: Wiley

3. Nanostructures and nanomaterials- G Cao and Y Wang- World Sci. 4. Graphene: Synthesis, Properties and Applications in Transparent electronic devices- P Kumar etal- Reviews in Advanced Sciences and Engineering, vol 2, pp1-21, 2013

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Model Question Paper for Course III (Ph.D. Physics)

NANOSTRUCTURES AND MATERIALS CHARACTERISATION

Time: 3 Hr **Total Marks: 50**

PART A

(Answer any *ten* questions. Each question carries 4 Marks)

1. Explain the quantum confinement in one dimension with an example
2. What are the features of self-assembled monopolymers?
3. What are fullerenes?
4. Explain spectrometric accuracy
5. Explain photoacoustic effect.
6. Give important applications of X-ray photoelectron microscopy.
7. What is meant by thermal analysis? Explain DTA.
8. How can SEM provide enlarged and highly resolved 3D view of specimen's exposed structure?
9. What is meant by fluorescence quenching? What are the types of quenching?
10. What is the role of molecular electronic state of a compound in fluorescence and phosphorescence emission?
11. What is the significance Moseley's law in periodic table?
12. What is biometrics? Explain with an example.

(10 x4 = 40)

PART B

(Answer one question. Each question carries 10 Marks)

13. Explain the principle and application of nanolithography.
14. Discuss the conceptual ideas of potential nano devices. What are the hindering factors in realizing them in practice?
15. What is the principle behind the working of FTIR spectrometer? Explain.
16. Discuss in detail the analysis of surface chemical composition with Auger emission spectroscopy method.

(1 x10 = 10)

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