# GUJARAT TECHNOLOGICAL UNIVERSITY

## NANO TECHNOLOGY (39)

**Characterization of Nanomaterials-II**

**SUBJECT CODE:** 2143905

B.E. 4th Semester

**Type of course:** Instrumentation in Nano science and Nanotechnology

**Prerequisite:** Require basic knowledge of computer operation and computer language which helps student to understand characterisation of Nanomaterial using different instrumental software, Solid State Physics and basic knowledge of Nanomaterial are also require to understand basic properties of Nanomaterial.

**Rationale :** The objective of this course is to make students familiar with different characterization techniques which are useful identifying physical, optical and biological properties of Nanomaterials

**Teaching and Examination Scheme:**

| Teaching Scheme | | | Credits | Examination Marks | | | | | | Total Marks |
|---|---|---|---|---|---|---|---|---|---|---|
| L | T | P | C | Theory Marks | | | Practical Marks | | | |
| | | | | ESE (E) | PA (M) | | PA (V) | | PA (I) | |
| | | | | | PA | ALA | ESE | OEP | | |
| 2 | 0 | 4 | 6 | 70 | 20 | 10 | 20 | 10 | 20 | 150 |

L- Lectures; T- Tutorial/Teacher Guided Student Activity; P- Practical; C- Credit; ESE- End Semester Examination; PA- Progressive Assessment

**Contents:**

| Sr. No. | Topics | Teaching Hrs. | Module Weightage |
|---|---|---|---|
| 1 | **Fourier Transform Infrared Spectroscopy (FTIR):** Introduction, Theory for FTIR, Sample analysis process, Simple Spectrometer Layout, Advantages of FTIR. | 5 | 15% |
| 2 | **Ultraviolet & visible spectrometry:** Introduction, Applications of UV/Visible Spectroscopy, Theory of UV/ Visible spectroscopy, Spectroscopy mechanism and working principle of UV/ Visible Spectroscopy | 5 | 15% |
| 3 | **SQUID:** Introduction Of Superconductor, Working Principle Of SQUID, Simple Characterisation of Magnetic materials By SQUID, Application of SQUID in different field | 5 | 15% |
| 4 | **VSM:** Introduction, Working principle of VSM, Simple Layout Of VSM techniques, Importance of VSM in Nano Technology. | 4 | 10% |
| 5 | **Impedance Spectroscopy:** | 5 | 15% |

| | | | |
|---|---|---|---|
| | Introduction, impedance in materials, Importance of Impedance Spectroscopy in Material Science. | | |
| 6 | **ATOMIC FORCE MICROSCOPY:** Introduction, Working Principle Of AFM, Applications Of AFM. | 4 | 15% |
| 7 | **MAGNETIC FORCE MICROSCOPY (MFM):** Introduction, Importance Of MFM, Working Principle of MFM. | 4 | 15% |

**Suggested Specification table with Marks (Theory):**

| **Distribution of Theory Marks** | | | | |
|---|---|---|---|---|
| R Level | U Level | A Level | N Level | E Level |
| 14 | 20 | 29 | 7 | - |

**Legends: R: Remembrance; U: Understanding; A: Application, N: Analyze and E: Evaluate and above Levels (Revised Bloom's Taxonomy)**

Note: This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may vary slightly from above table

**Reference Books:**


1. Encyclopedia of Materials Characterization Tools/Equipment, Brundle, Evans, Jr.Watson, Manning Publishing, 1992.
2. Fourier Transforms - New Analytical Approaches and FTIR Strategies Edited by Goran Nikolic, ISBN 978-953- 307-232-6, 538 pages, Publisher: InTech, Chapters published.
3. ULTRAVIOLET AND VISIBLE SPECTROSCOPY, 2ND ED By Michael Thomas
4. The SQUID Handbook: Fundamentals and Technology of SQUIDs, Volume 1 By John Clarke, Alex I. Braginski
5. Impedance Spectroscopy: Theory, Experiment, and Applications by Evgenij Barsoukov, J. Ross Macdonald
6. Magnetic resonance force microscopy and a single-spin measurement Gennady P. Berman, Fausto Borgonovi, Vyacheslav N Gorshkov, Vladimir I Tsifrinovich
7. Willard, Merritt, Dean, Settle, " Instrumental Methods of Analysis ", CBS publishers & Distributors, Delhi, Sixth Edition, 1986.
8. Colin N. Banwell and Elaine M. McCash, Molecular Spectroscopy, Mcgraw-Hill College; 4 Sub edition (June1, 1994), ISBN-10: 0077079760
9. Rainer Waser (Ed.), "Nano electronics and information technology", Wiley- VCH., Edition II, 2005.
10. Willard, Merritt, Dean & Settle, Instrumental Methods of Analysis, Wadsworth Publishing Company; 7 Sub edition (February 1988), ISBN-10: 0534081428.
11. P. J. Goodhew and F. J. Humphreys. Electron Microscopy and Analysis, 2rd Ed. Taylor and Francis, 1988.


**Course Outcome:**

- Get introduction of different and complicate techniques to characterized properties of Nanomaterials.

**List of Experiments:**

1. Data analysis using FTIR spectroscopy (peak identification)
2. Band gap measurement using FTIR spectroscopy (UV/NIR)
3. Surface analysis of thin film using **MAGNETIC FORCE MICROSCOPY (MFM)**
4. SQUID data analysis (magnetism).

5. Simple Method of Measuring the Band Gap Energy Value of $TiO_2$ in the Powder Form using a Visible Spectrometer
6. Impedance Spectroscopy: Introduction, impedance in materials, Importance of Impedance Spectroscopy in Material Science
7. C-V data analysis

**Open ended/design based Projects on Science and technology:-**

Open Ended /design based project: Apart from above experiments a group of students (Maximum Three) has to undertake one open ended problem/design problem. **(Students are free to select any area of science and technology may be based on their branch to define the project)**

Aims:
1. To provide experience in laboratory based experimentation, data recording and analysis and drawing of conclusions.
2. To develop report writing skills for scientific material
3. To develop the ability to undertake investigations where, as part of the exercise, the goals and methods have to be defined by the investigator.
4. To develop skills in literature searches and reviews.

Evaluation of Open ended / design based small project

1. Open ended / design based small project will be evaluated by external examiner with appropriate marks allotment given by GTU time to time.
2. Faculties should cultivate problem based project to enhance the basic mental and technical level of students.
3. Evaluation should be done on **approach of the student on his/her efforts** (not on completion) to study the design module of given task.

Examples
1. Characterization of any one material from local Industries.
2. A survey of Materials used in local industries and focus on the nature of microstructure and its manipulation and control to determine engineering properties.
3.Report on learning of Simulation software any characterization technique.

**ACTIVE LEARNING ASSIGNMENTS**: Preparation of power-point slides, which include videos, animations, pictures, graphics for better understanding theory and practical work – The faculty will allocate chapters/ parts of chapters to groups of students so that the entire syllabus to be covered. The power-point slides should be put up on the web-site of the College/ Institute, along with the names of the students of the group, the name of the faculty, Department and College on the first slide. The best three works should submit to GTU.