



# ST. ALOYSIUS COLLEGE(AUTONOMOUS), JABALPUR

*Reaccredited 'A+' Grade by NAAC(CGPA:3.68/4.00)*

*College with Potential for Excellence by UGC*

*DST-FIST Supported & STAR College Scheme by DBT*

## Faculty of Science

**Bachelor of Science (B.Sc.)**

**SUBJECT: NANOTECHNOLOGY**

**B.Sc. IV Semester**

**Paper-Major**

**ADVANCED TECHNIQUES FOR  
CHARACTERIZATION OF NANO-MATERIALS**

### COURSE OUTCOME

| CLO No.   | Course Outcomes  | Cognitive Level*   |
|-----------|--|--------------------|
| CLO -I    | Students will be able to understand the various aspects of XRD to do the structure analysis, phase analysis etc. | U, R, E            |
| CLO -II   | Students will be able to explain the working principle and use of SEM & AFM.                                     | U, R, Ap, An, E    |
| CLO - III | Students will be able to understand the working principle, operating modes and application of TEM & STM.         | R, U, Ap           |
| CLO - IV  | Students will understand the use of different spectroscopic techniques of material characterization.             | R, U, An, Ap, E, C |
| CLO -V    | Students will understand working principle and application of magnetic measurement techniques.                   | U, R               |





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## Credit and Marking Scheme

|              | Credits  | Marks    |          | Total Marks |
|--------------|----------|----------|----------|-------------|
|              |          | Internal | External |             |
| Theory       | 4        | 40       | 60       | 100         |
| Practical    | 2        | 40       | 60       | 100         |
| <b>Total</b> | <b>6</b> |          |          | <b>200</b>  |

## Evaluation Scheme

|           | Marks   |  |
|-----------|---|--|
|           | Internal  | External                                     |
| Theory    | 3 Internal Exams of 20 Marks<br>(During the Semester)<br>(Best 2 will be taken) | 1 External Exams<br>(At the End of Semester) |
| Practical | 3 Internal Exams<br>(During the Semester)<br>(Best 2 will be taken)             | 1 External Exams<br>(At the End of Semester) |



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## Content of the Course

### Theory

No. of Lectures (in hours per week): 4.5 Hrs. per week

Total No. of Lectures: 60 Hrs.+ Tutorials (5 Hrs.)

Maximum Marks: 60

| Units | Topics   | No. of Lectures |
|-------|--|-----------------|
| I     | <b>Diffraction analyses</b><br>X-ray diffraction, powder diffraction, lattice parameters, structure analysis, strain analysis, phase identification, particle size analysis using - Scherer's formula, X-ray photoelectron spectroscopy, (XPS)- Auger electron spectroscopy (AES).   | 13              |
| II    | <b>Scanning Electron Microscope (SEM) and AFM</b><br>SEM: Working Principle, Block diagram of instrument, Function and role of each block, Interaction of electron beam, Output form and its analysis, limitations, applications. Different versions of SEM: FESEM, Environmental SEM, Biological sample preparation, Importance and applications. Atomic Force Microscopy (AFM) : | 13              |
| III   | <b>Transmission Electron Microscope (TEM) and STM</b><br>Construction, Working Principle, Image formation, Different Operational Modes: Bright field and Dark field imaging, High Resolution (HR) / Lattice mapping imaging, Sample preparation for TEM, Applications.<br>Scanning Tunneling Microscopy (STM) : Construction, Working Principle, Applications.                     | 13              |
| IV    | <b>Spectroscopic techniques</b><br>Infrared spectroscopy (IR) – Rotational & Vibrational, UV-visible Spectroscopy, Raman Spectroscopy, Photoluminescence (PL)  | 13              |
| V     | <b>Magnetic measurements</b><br>Vibrating Sample Magnetometer (VSM) – Construction, Working and applications, Introduction to Superconducting Quantum Interference Device (SQUID) – Construction, Working and Applications.  | 13              |





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## References

### Test/Reference Books:

1. Encyclopedia of Material Characterization Edited by C. Richard Brundle, Charles A. Evans, Shaun Wilson, Butterworth, London.
2. Handbook of Microscopy, Applications in Materials Science, Solid State Physics and Chemistry, Edited by D. van Dyck, J. van Landuyt and G. van Tendeloo VCH,UK.
3. Handbook of Instrumental Techniques for Analytical Chemistry, Edited by Frank A. Settle, Printice Hall, PTR, New Jersey, USA.
4. Instrumental Methods of Analysis, by Willard, Merritt, Dean and Settle, CBS Publishers & Distributors; 7th edition (2004)
5. Bharat Bhusan, “Springer Handbook of Nanotechnology”, springer, Newyork, 2007.
6. Hari Singh Nalwa, “Encyclopedia of Nanotechnology”,USA 2011.
7. James A. Schwarz, Cristian I. Contescu, Karol Putyera, “Dekker encyclopedia of Nanoscience and Nanotechnology” CRC Press, 2004.
8. Textbook of Nanoscience and Nanotechnology by Murthy Raj Shankar Rath Murd
9. Nanotechnology an Introduction to Synthesis Properties and Applications of Nanomaterials by Thomas Verghese and K.M.Balkrishna.
10. Nanophysics and Nanotechnology by Wolf Edward
11. X-Ray Diffraction:,A Practical Approach by C.Suryanarayana
12. Nanotechnology : Principles and Practices by S. K. Kulkarni (3rd Edition)

### Web Links:

1. Introduction to Spectroscopy [dl.iranchembook.ir](http://dl.iranchembook.ir) › ebook › organic-chemistry-2753
2. An Introduction to Surface Analysis by XPS and AES | Wiley ... [onlinelibrary.wiley.com](http://onlinelibrary.wiley.com) › doi › book
3. EPMA - electron probe microanalysis [www.ems.psu.edu](http://www.ems.psu.edu) › harbin › EPMA.ppt.pdf





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4. Physical Property Measurement System [www.mrl.ucsb.edu](http://www.mrl.ucsb.edu) › instruments › hcapPPMS
5. [www.technologynetworks.com](http://www.technologynetworks.com) › sem-vs-tem-331262
6. [onlinelibrary.wiley.com](http://onlinelibrary.wiley.com) › abs › 9780470022184.hmm319 1.
7. [www.umassmed.edu](http://www.umassmed.edu) › maps › confocal-explanation

## List of Experiments

1. Study UV-Visible spectroscopy of nano-materials.
2. XRD pattern of nano-materials and estimation of particle size.
3. Particle size determination by X-ray diffraction (XRD) of the given XRD spectra
4. Spectroscopic characterization of metallic, semiconducting and insulating nanoparticles
5. To determine the Optical/Electronic band-gap of given sample through Tauc plots derived from UV-Vis diffused reflectance spectroscopy.
6. To determine the thickness of thin films using Ellipsometer/Reflectometer
7. To find out the chemical bond present in deposited thin films using FTIR
8. Validation of Lambert's-Beer's law using CuSO<sub>4</sub> solution.
9. To determine the structure and hkl parameter of the given crystal with XRD.
10. To study the effect of annealing on particle size

