Karmaveer Bhaurao Patil University, Satara

Yashavantrao Chavan Institute of Science,Satara

(Autonomous)

Syllabus under Autonomy for

Nanoscience and Technology

B. Sc. II

As Per NEP-2020

Academic Year 2024 - 2025

Credit Distribution for Second Year of Four Year UG Honors Degree

Class	Level	Sem	Subject-1 Major		Subject-2 Minor		VSC	SEC	AEC	VEC	CC	Total
			T	P	T	P						
B.Sc. II	5.0	III	4 (2 Theory Papers)	4 (2 Practical Papers)	2	2	2	2	4	2	--	22
		IV	4 (2 Theory Papers)	4 (2 Practical Papers)	2	2	2	2	4	--	2	22

B. Sc. II Semester III

Course	Paper Code	Paper Title
Major Paper I	BNTT 231	Basic Characterization Techniques For Nanomaterial
Major Paper II	BNTT 232	Advanced Characterization Techniques For Nanomaterial
Major Practical I	BNTT 233	Major Practical - I
Major Practical II	BNTT 234	Major Practical - II
Minor Paper I	BNTT 234	Sensors and Transducers
Minor Practical	BNTT 235	Minor Practical-I
VSC	BNTTVSC-I	Thin Film Coating Techniques I
SEC	BNTTSEC-II	IR Spectrophotometry Techniques
AEC	BNTTAEC-I	English
VEC	BNTTVEC-II	Role of Nanotechnology in Environmental Science

B. Sc. II Semester VI

Course	Paper Code	Paper Title
Major Paper I	BNTT 241	Nanobiotechnology
Major Paper II	BNTT 242	Mechanics
Major Practical I	BNTT 243	Major Practical - III
Major Practical II	BNTT 244	Major Practical - IV
Minor Paper I	BNTT 245	Nano chemistry
Minor Practical	BNTT 246	Minor Practical-II
VSC	BNTTVSC-II	Thin Film Coating Techniques II
SEC	BNTTSEC-III	Sensor Technology
AEC	BNTTAEC-I	English
CC	BNTTVC-II	Art of Story Telling

B. Sc. II Nanoscience and Technology Semester III

Major Paper

BNTT 231: Basic Characterization Techniques for Nanomaterial

Objectives: Students will be able to

1. Learn different characterization techniques.
2. Evaluate Absorbance and Transmittance of materials by using UV-Vis spectroscopy.
3. Gain Knowledge of theories behind data analysis.
4. Remember the Concept of Fluorescence and Phosphorescence Spectroscopy.

Unit No.	Basic Characterization Techniques for Nanomaterial	Lectures 30 Credit (2)
UNIT I	**Electromagnetic Spectrum:** Introduction, Nature of electromagnetic Radiation, Atomic and molecular theory. **UV-Visible Spectroscopy:** Introduction, Working principle, Instrumentation, Sample Preparation, Advantages, Disadvantages, Application of UV-Visible Spectroscopy.	**06**
UNIT II	**Infrared Spectroscopy:** Introduction of IR spectrum, Instrumentation: Radiation source, Detector, Readout Module, Advantages, Applications, Interpretation of IR spectra. **FTIR:** Introduction, Instrumentation, Advantages, Disadvantages, Applications	**08**
UNIT III	**Raman Spectroscopy** Introduction, Theory of Raman Effect, Why Raman is different from IR, Instrumentation, Advantages, Disadvantages and Application of Raman Spectroscopy.	**08**
UNIT IV	**Fluorescence and Phosphorescence Spectroscopy** **Fluorescence Spectroscopy:** Introduction, Theory of Fluorescence, Principle, Working, Construction and Application, Advantages and Disadvantages of Fluorescence Spectroscopy. **Phosphorescence Spectroscopy:** Introduction, Theory of Phosphorescence, Principle, Working, Construction and Application, Advantages and Disadvantages of Phosphorescence Spectroscopy.	**08**

Course Outcomes: After completion of course students should be able to

1. Explain the Principle, working and Application of Basic Characterization Techniques of Nanomaterials.
2. Describe the terms involved in Characterization Techniques.
3. Understand the working of Instrumentation of different spectroscopy.
4. Explain mechanism of fluorescence and phosphorescence spectroscopy.

References:

1. Nan Yao, Zhong Lin Wang, Handbook of Microscopy for Nanotechnology, Springer, 2005
2. R. S. Chaugule, R. V. Ramanujan. Textbook: Nanoparticles: SynthesisCharacterization and Applications, American Scientific publisher, 2010
3. H. Kaur, Instrumental Methods for Chemical Analysis, Pragati Prakashan, 2012
4. Lynne L. Merritt, Instrumental Methods of Analysis, CBS Publication, 1990
5. Douglas A. Skoog, Donald M. West, Principles of Instrumental Analysis, 1980

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B. Sc. II Nanoscience and Technology Semester III

Major Paper

BNTT 232: Advanced Characterization Techniques for Nanomaterial

Objectives: Students will be able to

1. Study the characterization techniques.
2. Learn about crystalline size of materials by using X-Ray Diffraction.
3. Imbibe principles of SEM, TEM and AFM microscopies.
4. Analyze the materials by using characterization techniques.

Unit No.	Advanced Characterization Techniques for Nanomaterial	Lectures 30 Credit (2)
UNIT I	**X-Ray Diffraction (XRD):** Introduction, Theory of XRD, Production of X-rays and X-ray spectra, Instrumental units: sources, X –ray tube, crystal monochromators, detectors for measurement of X- ray radiation. **X-ray spectroscopy:** Principle, absorption, emission and diffraction of X-rays, Bragg's Law, Powder Method, Principle of the Powder Method, Key Characteristics and Application.	**12**
UNIT II	**Atomic Absorption Spectrometry** Introduction, Theory of AAS, Spectroscopic sources hollow cathode lamps, Single beam spectrophotometer, Double beam	**06**

	Spectrophotometer, Atomic absorption spectrometry, Nebulizer and atomizer.	
UNIT III	**Atomic Emission Spectroscopy** Introduction, Theory of Atomic Emission Spectroscopy, Instrumentation, Sample atomization, Continuous atomizers, Discrete atomizers, Atomic emission spectra, Atomic fluorescence spectra.	**06**
UNIT IV	**Microscopy** Introduction of Scanning Electron Microscopy (SEM): Construction, Principle and working, Atomic Force Microscopy (AFM): Construction, Principle and Working. Transmission Electron Microscopy (TEM): Construction, Principle and Working.	**06**

Course Outcomes: After completion of course students should be able to

1. Calculate vibrational frequency using of Raman spectrometry.
2. Explain principle of XRD construction and working of XRD
3. Analyze Atomic Absorption Spectrometry
4. Define construction, working and principle of SEM, TEM, AFM.

References:

1. Larkin Peter J. Infrared and Raman Spectroscopy: Principle and spectral interpretation, Second edition, Elsevier Science 2017.
2. John R. Ferraro, Chris W, Brown. Introductory Raman Spectroscopy, Second edition, Elsevier Science 2003.
3. Cullet D.B, Stock. S.R, Elements of X-Ray Diffraction Third Edition, 2014.
4. Samuel H. Cohen and Marcia L. Lightbody Atomic Force Microscopy and Scanning Tunneling Microscopy, Kluwer academic publisher, 2005.
5. Elwell W. T, Gidley J. A , Atomic Absorption Spectrophotometry, Second edition , Pergamon Press 1966.

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B. Sc. II Nanoscience and Technology Semester III

Major Practical

BNTT 233: Practical Course I

Lectures 30 Credit (2)

Objectives: Students will be able to

1. Gain Knowledge in Characterization Techniques.
2. Study Analysis of Materials by using Characterization Techniques.
3. Study the Composition of Materials.
4. Learn Spectral Analysis of FTIR, Raman and UV-Visible Spectroscopy.

Sr. No.	List of Experiments
1.	Data Interpretation and Plotting.
2.	Calculate Absorbance of given Material of by UV-Vis. Spectroscopy.
3.	Calculate Transmittance of given Material by UV-Vis. Spectroscopy.
4.	Calculate the Band gap of given Material of by using Tauc Plot
5.	To Verify Lamberts Beers Law.
6.	Dye Concentration using UV-Vis. Spectroscopy.
7.	Interpretation of IR Spectra : Hydroxyl O-H Stretch and Amine N-H Stretch
8.	Interpretation of IR Spectra : Carbonyl C=O Stretch
9.	Interpretation of IR Spectra : Alkyne and Nitrile Stretches
10.	Interpretation of IR Spectra : Alkene and Aromatic C=C Stretch
11.	Interpretation of IR Spectra : C-H Stretching and Bending
12.	Interpretation of IR Spectra : C-O Stretch
13.	Raman Spectra Interpretation.
14.	Fluorescence Spectra Interpretation.
15.	Phosphorescence Spectra Interpretation.

Course Outcomes: After completion of course students should be able to

1. Calculate the absorbance and Transmittance of materials by using UV-Vis. Spectroscopy.
2. Calculate the Composition of Materials by using IR Spectroscopy.
3. Remember the Characterization Techniques.
4. Explain the Spectral analysis of FTIR, Raman, Florescence, etc.

References:

1. Nan Yao, Zhong Lin Wang, Handbook of Microscopy for Nanotechnology, Springer,

2005

2. R. S. Chaugule, R. V. Ramanujan. Textbook: Nanoparticles: Synthesis Characterization and Applications, American Scientific publisher, 2010
3. H. Kaur, Instrumental Methods for Chemical Analysis, Pragati Prakashan, 2012

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B. Sc. II Nanoscience and Technology Semester III

Major Practical

BNTT 234: Practical Course II

Lectures 30 Credit (2)

Objectives: Students will be able to

1. Gain knowledge in characterization techniques.
2. Study analysis of the materials by using characterization technique.
3. Study Morphology of materials.
4. Learn spectral analysis of XRD, SEM, TEM, AFM etc.

Sr. No.	List of Experiments
1.	Studies on X-Ray Diffractions
2.	Determination of Crystalline Size using Scherrer formula
3.	Structural Analysis Using XRD
4.	Data interpretation and plotting XRD Graph
5.	Interpretation of X-ray powder pattern of a given crystalline compound of a nanomaterial.
6.	Analysis of atomic absorption spectra
7.	To study principle and working of SEM
8.	Scanning Electron Microscope image interpretation
9.	Structural Properties of SEM
10.	To determine the size of metal nanoparticle by plotting the frequency distribution from the given SEM image
11.	Determination of average particle size by frequency distribution curve by Sieve method.
12.	Calculation of the concentration of colloidal nanoparticles

	from the given TEM image using the concentration of precursor.
13.	To Study principle and working of AFM.
14.	Atomic Force Microscope image interpretation.
15.	To determine the surface area of volume of particle colloidal

Course Outcomes: After completion of course students should be able to

1. Calculate crystal structure of materials by using XRD.
2. Explain atomic stretching in materials by using IR spectrometer.
3. Analyze morphology of materials by using SEM, TEM and AFM images.
4. Calculate the surface area of colloidal materials by using image of SEM

References:

1. Prushan. M. J, Instrumental Analysis Lab Manual , CHM 311, 2018.
2. Elwell W. T, Gidley J. A , Atomic Absorption Spectrophotometry, Second edition , Pergamon Press 1966.
3. Nan Yao. Zhong Lin Wang Microscopy for Nanotechnology, by Kluwer Academic Public, 2005.

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B. Sc. II Nanoscience and Technology Semester III

Minor Paper

BNTT 235: Sensors and Transducers

Objectives: Student will be able to

1. Understand the working of sensors and transducers
2. Learn error analysis by statistical method
3. Perform configuration of AC and DC bridge circuits for electrical Measurement
4. Learn the Data converter and acquisition techniques

Unit No.	Sensors and Transducers	Lectures 30 Credit (2)
UNIT I	**Measurement and error:** Static and dynamic characteristics of an instrument, error in the measurements and types of static error, dynamic response of an instrument, significant figure and rounding off the numbers, statistical analysis.	**06**

UNIT II	**Sensors and Actuators** Classification of transducer, selecting of transducer, Electrical Transducers and their parameters **Types of Transducers:** Electro acoustic transducers (microphone and speaker), Force/Pressure transducers (resistance pressure transducer, strain gauge, and load cell), Temperature Transducers (Thermistor, Thermocouple and RTD), Fiber Optical sensors, Smart sensors. **Signal conditioner:** Introduction to Instrumentation Amplifier and active filters.	**08**
UNIT III	**Measurement techniques** **Impendence measurement:** Introduction, resistance measurement- Voltmeter-Ammeter method and Whetstone Bridge method, measurement of low resistance: Kelvin's bridge method **Inductance measurement:** Maxwell's bridge **Capacitance measurement:** Schering bridge **Frequency measurement:** Wien bridge	**08**
UNIT IV	**Data Converter and Data Acquisition System** **Data converter:** D/A converter: Weighted resistor network and R-2R network, A/D Converter: A/D Converter circuit: parallel comparator, successive approximation, and dual slope ADC. **Data Acquisition System:** Block diagram of DAS, objective of DAS, single channel and multi-channel Data Acquisition System, computer based data acquisition system and data Loggers.	**08**

Course Outcomes: After completion of course students should be able to

1. Perform error analysis by statistical methods
2. Understand basic principles of sensors and transducers.
3. Measure electrical quantities by means of AC and DC Bridge.
4. Apply Data converters and Data acquisition systems.

References:

1. H. S. Kalsi, Electronic Instrumentaion, TMH(2006)
2. W.D. Cooper and A. D. Helfrick, Electronic Instrumentation and Measurement Techniques, Prentice- Hall (2005).

3. Nakra B C, Chaudry K, Instrumentation Measurement and analysis: TMH
4. E.O.Doebelin, Measurement Systems: Application and Design, McGraw Hill Book - fifth Edition (2003).
5. Joseph J Carr, Elements of Electronic Instrumentation and Measurement, Pearson Education (2005)
6. David A. Bell, Electronic Instrumentation and Measurements, Prentice Hall (2013).
7. Oliver and Cage, "Electronic Measurements and Instrumentation", TMH (2009).
8. Alan S. Morris, "Measurement and Instrumentation Principles", Elsevier (Buterworth Heinmann- 2008).
9. K Sawhney, Electrical and Electronics Measurements and Instrumentation, Dhanpat Rai and Sons (2007).
10. C. S. Rangan, G. R. Sarma and V. S. Mani, Instrumentation Devices and Systems, Tata Mcgraw Hill (1998).

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B. Sc. II Nanoscience and Technology Semester III

Minor Practical

BNTT 236: Practical Course I

Lectures 30 Credit (2)

Objectives: Students will be able to

1. Learn Error analysis
2. Study the characteristics of various types of transducers
3. Learn Data converter techniques
4. Designing of AC and DC Bridge for measurement.

Sr. No.	List of Experiments
1.	Study of Uncertainty & Errors
2.	Study of Instrumentation Amplifier
3.	Study of Load Cell
4.	Study of LVDT
5.	Study of Strain Gauge

6.	Study of Thermistors
7.	Study of LDR
8.	Study of Photodiode
9.	Study of Phototransistor
10.	Study of Analog to Digital Converter
11.	Study of Digital to Analog Converter
12.	Study of Fiber optic sensor
13.	Study of Wien bridge
14.	Study of Whetstone Bridge for Resistance Measurement
15.	Study of Schering Bridge for Capacitance Measurement

Course Outcomes: After completion of course students should be able to

1. Analyze errors in measurement
2. Study the characteristics of various types of transducers
3. Apply Data converter techniques
4. Designing of AC and DC Bridge for measurement.

References:

1. H. S. Kalsi, Electronic Instrumentaion, TMH(2006)
2. W.D. Cooper and A. D. Helfrick, Electronic Instrumentation and Measurement Techniques, Prentice- Hall (2005).

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B. Sc. II Nanoscience and Technology Semester III

BNTPVSC I: Thin Film Coating Techniques I

Lectures 30 Credit (2)

Objectives: Students will be able to

1. Understand Synthesis of Thin film coating in various methods.
2. Understand Properties for thin film.
3. Understand various Optical properties of thin film.
4. Study various types of material synthesis and uses of coating.

Sr. No.	List of Experiments
1.	Synthesis of Fe_2O_3 thin film by using CBD Method
2.	Synthesis of TiO_2 thin film by using CBD Method
3.	Synthesis of Ferrite thin film by CBD Method

4.	Synthesis of ZnO thin film by using CBD Method
5.	Synthesis of Cds thin film by using CBD Method
6.	Synthesis of SnO_2 thin film by using CBD Method
7.	Synthesis of Polyaniline Nano fibers by CBD Method
8.	Preparation of Super hydrophobic Nano coatings by spin coating method.
9.	Synthesis of CdS thin film by SILAR method
10.	Synthesis of SnO_2 thin film by SILAR Method.
11.	Synthesis of CdS thin film by SILAR Method.
12.	Synthesis of MgO thin film by SILAR Method.
13.	Electrodeposition and anodization of thin film
14.	Preparation of film by Doctor Blade method
15.	Microwave Synthesis of thin film
16.	Preparation of Nickel ferrite thin film by Hydrothermal method
17.	Carrier concentration by Hall effect
18.	Resistivity measurement of thin film.
19.	Optical Properties of thin film (Transmittance)
20.	Optical Properties of thin film (Absorbance)

Course Outcomes: After completion of course students should be able to

1. Develop Skill for measuring physical, optical and electrical properties of materials.
2. Know the principle and working of various synthesis methods.
3. Have an idea about the growth mechanism of nanoparticles.
4. Use different nanoparticles synthesis methods.

References:

1. Dr. Gerrard Eddy Jai, A Laboratory Course in Nanoscience and Nanotechnology by Poinern, CRC Press, Taylor and Francis Group, 2015.
2. Zhong lin wang, Handbook of microscopy for nanotechnology by Nano Princeton University USA, Kluwer Academic Publishers, 2005.
3. Dorothy m. Hoffman, Handbook of vacuum science and technology , Academic Press, 1998.
4. Elwell W. T, Gidley J. A , Atomic Absorption Spectrophotometry, Second edition , Pergamon Press 1966.
5. Nan Yao. Zhong Lin Wang, Microscopy for Nanotechnology, by Kluwer Academic Public, 2005.

6. Bharat Bhushan, Springer Handbook of Nanotechnology, ,Springer Verlag,(2007).
7. Challa S., S. R. Kumar, J. H. Carola Nanofabrication towards biomedical application: Techniques, tools, John Wiley and sons.2006.

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B. Sc. II Nanoscience and Technology Semester III

BNTTSEC-II: IR Spectrophotometry Techniques

Lectures 30 Credit (2)

Objectives: Students will be able to

1. Study the advantages of IR Spectrophotometer.
2. Study the concept interpretation of IR Spectrophotometer.
3. Use of IR Spectrophotometer in various areas.
4. Determine the technique to handling the instruments**.**

Sr. No.	List of Experiments
1.	Introduction of Infrared Spectrophotometer
2.	Use of IR spectrophotometer in various field
3.	Sample preparation for IR spectra
4.	Sample evaluation of IR spectra
5.	Graph plotting of IR spectra using Origin Software
6.	Study of Stretching and Bending vibrations of IR spectra
7.	Interpretation of IR Spectra : Hydroxyl O-H Stretch and Amine N-H Stretch
8.	Interpretation of IR Spectra : Carbonyl C=O Stretch
9.	Interpretation of IR Spectra : Alkyne and Nitrile Stretches
10.	Interpretation of IR Spectra : Alkene and Aromatic C=C Stretch
11.	Interpretation of IR Spectra : C-H Stretching and Bending
12.	Interpretation of IR Spectra : C-O Stretch
13.	Interpretation of IR spectra Sample I
14.	To study IR spectra for common organic solvent: Acetone.
15.	To study IR spectra for common organic solvent: Acetonitril
16.	To study IR spectra for common organic solvent: 1- Butanol
17.	To study IR spectra for common organic solvent: Cyclohexane

18.	To study IR spectra for common organic solvent: Chloroform
19.	To study IR spectra for common organic solvent: Nitromethane
20.	Interpretation of IR spectra Sample I

Course Outcomes: After completion of course students should be able to

1. To understand theoretical knowledge of Infrared spectrophotometer.
2. To learn various types of functional groups
3. Understand plotting of IR spectra.
4. Identify different functional groups by using IR spectrophotometer

References:

1. Barbara H. Stuart, Infrared Spectroscopy: Fundamentals and Applications, john Wiley and Sons, Ltd 2004
2. Nan Yao, Zhong Lin Wang, Handbook of Microscopy for Nanotechnology, Springer, 2005
3. Infrared Spectral Interpretation by Brian Smith, CRC Press, 1999
4. Barbara Atuart, Infrared Spectroscopy: Fundamentals and Applications John Wiley & Sons, 2004
5. Erno Pretsch, Philippe Bahlmann, Martin Badertscher, Structure determination of organic compounds, Fifth Edition 2020

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B. Sc. II Nanoscience and Technology Semester III

BNTTAEC-I: English

Lectures 30 Credit (2)

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B. Sc. II Nanoscience and Technology Semester III

BNTTVEC-II: Role of Nanotechnology in Environmental Science

Lectures 30 Credit (2)

Objectives: Students will be able to

1. To study about environmental pollution
2. Knowledge about various acts for water and air pollution.
3. Understand concept of toxic ions.
4. Understand application of Nanoparticles for treatment of environmental pollutions.

Unit No.	Role of Nanotechnology in Environmental Science	Lectures 30 Credit (2)
UNIT I	**Water Pollution** Water Pollution, Sources and measurement of water pollution, Need for water management, Effect and control of water pollution, The environmental protection act:1986, Nanotechnology used in waste water treatment	**08**
UNIT II	**Air Pollution** Air pollution, Sources of air pollution, Need for air pollution management, Air pollution control act 1981, Air purifiers using nanomaterials, Application of nanotechnology in air purifiers.	**08**
UNIT III	**Applied Nanotechnology** Environmental contaminants, Types of environmental Sensor, Sensing of chemical pollutants (Gas sensor)	**07**
UNIT IV	**Application of Nanoparticles for Adsorption of toxic ions** Introduction, Environmentally toxic ions, Hierarchy of solid structure and adsorption, Various types of nanoparticles for degradation of toxic ions.	**07**

Course Outcomes: After completion of course students should be able to

1. Know the act of water pollution.
2. Understand source of Air pollution.
3. Understand applied nanotechnology.
4. Understand types of environmental sensor

References:

1. Nyamadzi M. Z., Reference Handbook of Nanotoxicology, Environmental Health Perspectives, 2005
2. Metcalf and Eddy, Tata Mc Graw Hill, Waste Water Engineering-treatment, 1999.
3. Wiley A. K., Environmental Chemistry, Estern Ltd, 2003.
4. Maiti S. K., Water and Waste Analysis, Handbook of Method in Environmental Studies, ABD publication, 2007.

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B. Sc. II Nanoscience and Technology Semester IV

Major Paper

BNTT 241: Nano-Biotechnology

Objectives: Students will be able to

1. Understand structure and functions of important biomolecules.
2. Study nutrient media for bacterial isolation.
3. Learn different culture techniques for isolation of bacteria.

Unit No.	Nano-Biotechnology	Lectures 30 Credit (2)
UNIT I	**Proteins:** Overview of amino acids and proteins, Peptide bond, Primary, Secondary, Tertiary and Quaternary structures, Fibrous protein, Globular protein. Protein stability, Protein folding and denaturation.	**06**
UNIT II	**Lipids and Nucleic acid**: Lipid Classification, Fatty Acids, Triacylglycerols, Glycerophospholipids, Sphingolipids Cholesterol. Storage Lipids, Lipids as Signals, Cofactors, and Pigments. **Applications of Nano-capsules:** Nano-capsule for efficient delivery of pesticides, fertilizers and other agrochemicals, Liposomal nano- capsules in food Science and agriculture	**08**
UNIT III	**Microbial Nutrients:** Culture media: Synthetic or defined media, complex media, types of media, selective media, differential media. Common nutrient requirements, requirements for carbon, hydrogen, and oxygen, types of microorganisms based on nutritional requirements.	**06**
UNIT IV	**Pure culture techniques:** Isolation of pure cultures, spread plate, streak plate, pour plate method. colony morphology and growth. Cultivation and Maintenance of microorganisms: Nutritional categories of micro-organisms, methods of isolation, Purification and preservation.	**08**

Course Outcomes: After completion of course students should be able to

1. Know structures of different carbohydrates, classification of carbohydrates.
2. Classify lipids, structures of different lipids, functions of lipid in biological system.
3. Know classification of micro-organism's based on their nutrient media, carbon and energy source.

References:

1. Lehninger's- Principles of Biochemistry, D. L. Nelson and M. M. Cox , CBS

Publications, 7th edition, United Kingdom, 2017.

2. Biochemistry, Jermey berg, Lubert Stryer, W.H. Freeman and Company, 5th Edition, Dallas, TX, United States, 1975.
3. General Microbiology, Stanier, Adelbergand Ingraham, 4th Edition, The Macmillan Press Ltd, Hong Kong, 1976.
4. Cell biology, genetics, molecular biology, evolution and ecology, Verma and Agarwal, 4th edi. S. Chand and company, New Delhi, 2006.
5. Molecular Cell Biology, Lodish et al., 5th ed - W.H. Freeman & Company, New York, United states, 2006.

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B. Sc. II Nanoscience and Technology Semester VI

Major Paper

BNTT 242: Mechanics

Objectives: Students will be able to

1. Learn the vector algebra and basic vector calculus and difference between scalars and vectors.
2. Understand differential equations.
3. Explain the concept of dynamics of a system of particles
4. Know the concept of rotational motion and moment of inertia of various bodies.

Unit No.	Mechanics	Lectures 30 Credit (2)
UNIT I	**Vector Algebra and Elementary Calculus** Vector algebra, Scalar and vector products, Derivatives of a vector with respect to parameters (velocity and acceleration)	**06**
UNIT II	**Ordinary Differential Equations:** Differential equations; degree, order, linearity and homogeneity of differential equation, ordinary and partial differential equations, Exact differentials, 1^{st} order homogeneous differential equations, 2^{nd} order homogeneous	**08**

	differential equation with constant coefficients, Problems.	
UNIT III	**Dynamics of a system of particles** Frames of reference, Newton's Laws of motion, Conservation of linear and angular momentum, work and energy theorem, conservation of energy (Single Particle), Dynamics of a system of particles (linear momentum, angular momentum and energy), Centre of mass, Motion of rocket (qualitative treatments only), Problems	**08**
UNIT IV	**Rotational Motion** Angular velocity and angular momentum, Torque, Analogy between translational and rotational motion, Relation between torque and angular momentum, Kinetic energy of rotation and moment of inertia, Moment of Inertia of spherical shell; solid cylinder (only about the axis of symmetry), Motion of spherical shell and solid cylinder rolling down an inclined plane, Problems.	**08**

Course outcomes: After completion of course students should be able to

1. Define scalar, vector and their products and perform the basic algebra operations of scalars and vectors.
2. Understand basic mathematics used to express phenomena in mechanical systems.
3. Explain laws of motion.
4. Solve the problems based on angular variables.

References:

1. Walker, Halliday and Resnick, Fundamentals of Physics, Hoboken, New Jersey: John Wiley & Sons, 11th Edition, 2018.
2. H. C. Verma, Concepts of Physics –Part–I, Bharati Bhawan Publishers, Revised Edition, 2018.
3. Charles Kittel, Knight, Ruderman et al., Mechanics, New York: Berkeley Physics Course, Vol.1, Tata McGraw Hill Publications, 2nd Edition, 2017.
4. H. K. Das, Dr. Rama Verma, Mathematical Physics, New Delhi: S. Chand Publication,7th Edition, 2014.
5. B. D. Gupta, Mathematical Physics Mumbai: Vikas Publication House,4th Edition, 2010.
6. D.S. Mathur, Mechanics, New Delhi: S. Chand and Company Ltd. 2007.
7. K. F. Riley, M. P. Hobson, S. J. Bence, Mathematical Methods for Physics and

Engineering, Cambridge: Cambridge University Press,3rd Edition, 2006.

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B. Sc. II Nanoscience and Technology Semester IV

Major Practical

BNTT 243: Practical Course III

Lectures 30 Credit (2)

Objectives: Students will be able to

1. Study different staining techniques of bacteria.
2. Learn the biochemical isolation of bacteria and characterization of bacteria.
3. Study preparation of media and sterilization techniques.
4. Understand separation of amino acids by paper chromatography

Sr. No.	List of Experiments
1.	Preparation of cultural media
2.	Sterilization methods of cultural media
3.	Method of isolation of bacteria from different sources
4.	Staining methods: simple staining, Gram staining, negative staining, and hanging drop.
5.	Isolation and enumeration of bacteria using streak plate technique
6.	Isolation and enumeration of bacteria using spread plate technique
7.	Isolation and enumeration of bacteria using pour plate technique
8.	Determination of bacterial cell size by micrometry
9.	Enumeration of microorganism - total & viable count. Separation of Amino acids by paper chromatography.
10.	Qualitative tests for Carbohydrates, lipids and proteins
11.	Estimation of protein concentration by Lowry method.
12.	Estimation of reducing sugar concentration by DNSA method.
13.	To study the growth curve of E.coli bacteria
14.	To study the growth curve of Bacillus subtilis bacteria
15.	Estimation of total sugar concentration by Phenol-H_2SO_4 method

Course Outcomes: After completion of course students should be able to

1. Understand isolation and characterization of bacteria
2. Calculate qualitative estimation of biomolecules.
3. Develop technique of paper chromatography, different staining.
4. Prepare nutrient media for bacterial isolation.

References:

1. Fiona frais, Practical Biochemistry: An Introductory Course , England Publisher:

London, 1972,

2. S. Jayaraman, A Textbook of Practical Biochemistry, APC, 2018.
3. S. Jayaraman, Laboratory Manual in Biochemistry, ,New Age, 3rd edition, 2011

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B. Sc. II Nanoscience and Technology Semester VI

Major Practical

BNTT 244: Practical Course VI

Lectures 30 Credit (2)

Objectives: Students will be able to

1. Develop fundamental experimental skills to perform an experiment.
2. Develop skills from these instruments and learn, analyze and interpret experimental data, including error analysis, graphical representation.
3. Perform calculations to obtain the experimental results and test whether the experimental results hold well with theoretical results.
4. Acquire knowledge and practice safe laboratory procedures, including proper handling of equipment, electrical, and potential hazards.

Sr. No.	List of Experiments
1.	Measurements of length/diameter using Vernier caliper, Screw gauge and Travelling Microscope.
2.	To determine the Moment of Inertia of a Flywheel.
3.	To determine Moment of inertia of a disc using auxiliary annular ring.
4.	To determine ‘g’ by bar pendulum.
5.	To determine ‘g’ by Kater’s pendulum (fixed knife edges).
6.	To determine ‘g’ by Kater’s pendulum (movable knife edges).
7.	To study the motion of a spring and calculate (a) spring constant (b) value of ‘g’.
8.	To study the motion of a spring and calculate (a) spring constant (b) value of ‘g’.
9.	To study turning effect of force
10.	To verify the principle of moments (clock wise and anti-clock wise)

	by using a meter rod balanced on a wedge
11.	To determine the moment of inertia of a body using bifilar suspension method (with parallel thread)
12.	To validate the energy theorem and study the conservation of energy principle
13.	To study the oscillations in a bifilar suspension arrangement.
14.	Calculating the rotational kinetic energy from inertia.
15.	To find the weight of a given body using parallelogram of vectors

Course Outcomes: After completion of course students should be able to

1. Experiment skill set up safely and efficiently, instruments calibration, carry out experimental procedure, data collection, analysis and report it in a written sheet manner.
2. Exhibit practical skills in using various measuring instruments (Vernier caliper, micrometer screw gauge, travelling microscope)
3. Display practical skills in measuring moment of inertia using various experiments.
4. Learn skills in measuring time period of oscillation for Kater's and bar pendulum

References:

1. Gupta S.L. and V. Kumar., Practical physics. Meerut: Pragati Prakashan, 29th Edition. 2017.
2. Chattopadhyay D. and P. C. Rakshit, An advanced course in practical physics Calcutta: New Central Book, 8th Edition, 2013.
3. Prakash and Ramakrishna, A Textbook of Practical Physics, Kitab Mahal,11th Edition, 2011.
4. Singh H. Harnam and Hemne P. S., B.Sc. Practical Physics, New Delhi, S. Chand & Co. Ltd., 17th Edition, 2011

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B. Sc. II Nanoscience and Technology Semester VI

Minor Paper

BNTT 235: Nano-Chemistry

Objectives: Students should be able to

1. Define Physiochemical Principles of Analytical Chemistry.
2. Gain Knowledge of theories behind study of Periodic table.
3. Know the technical idea of separation of components from their mixtures by Chromatography.
4. Remember the Concept of Catalysis and its Application.

Unit No.	Nano-Chemistry	Lectures 30 Credit (2)
UNIT I	**Introduction, Basic Principle of Physicochemical Analysis:** Equivalent and Molar Conductivity and their Variation with Dilute and Strong Electrolytes, Determination of degree of ionization of Weak electrolytes, Concept of EMF of cell, Reversible and Irreversible cells, Nernst Equation and its importance, Electrochemical Synthesis, Deposition of Nanomaterials, Solved Problems.	**08**
UNIT II	**Principles of Chromatography:** Introduction, Basic Principles of Chromatography, Classification of Chromatography- Paper and TLC Chromatography, Types of Paper and treatments, Sample Loading, Determination of Rf Value, Application , Advantages and Disadvantages, Solved Problems.	**08**
UNIT III	**Chemistry of elements of first Transition Series:** Position of elements in periodic table: Characteristics of d-block elements with special reference to i) Electronic Configuration ii) Oxidation states iii) Magnetic Character iv) Colored Ions v) Complex Formation.	**08**
UNIT IV	**Catalysis** Introduction, Classification of Catalytic Reactions- Homogeneous and Heterogeneous, Types of Catalysis, Characteristics of Catalytic Reactions, Mechanism of Catalysis i) Intermediate Compound Formation ii) Adsorption Theory.	**06**

Course Outcomes: After Completion of Course, Student will be able to

1. Explain the Physico-chemical principles of basic chemical analysis.
2. Analyze Characterizes of d-block elements.
3. Difference between chromatographic Techniques.
4. Understand Types of Catalysis and Characteristics of Catalytic Reactions.

References:

1. Lee J. D. Concise Inorganic Chemistry, (Wiley India Editor 5th edition 2008).
2. Schubest U and Housing N Synthesis of Inorganic Materials, (Wiley VCH, 2000).
3. Anthony F. Hill Organo transition Metal Chemistry, Royal Society of Chemistry,

Tutorial Chemistry Text, 2002.

4. Shriver and Atkins, Inorganic Chemistry, (UK: Oxford 4th edition, 2003).
5. Khopkar, S. M. Basic Concepts of Analytical Chemistry, New Age, International Publisher, 2009.
6. Sharma. B. K. Industrial Chemistry Goel Publishing Housing, 1st edition, 2011.
7. Morrison and Boyd Organic Chemistry, Pearson Education India, 7th edition, 2010.

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B. Sc. II Nanoscience and Technology Semester VI

Minor Practical

BNTT 246: Practical Course II

Lectures 30 Credit (2)

Objectives: Students will be able to

1. Understand Concept of Cell Constant.
2. Understand Potentiometric Titrations.
3. To learn Organic Estimation and Preparation Methods.
4. To study Basic Principles of Chromatography.

Sr. No.	List of Experiments
1.	Determination of Cell Constant.
2.	Conduct metric titrations-Strong Acid vs. Strong Base
3.	Potentiometric Titrations- Strong Acid vs. Strong Base
4.	Potentiometric Titrations- Weak Acid vs. Strong Base
5.	Polari meter
6.	To Verify Lamberts Beer's Law using colorimeter.
7.	Chemical Kinetics I
8.	Chemical Kinetics II
9.	Chemical Kinetics III
10.	Preparation of Ferrous Ammonium Sulphate.
11.	Preparation of Tetraammino Copper sulphate.
12.	Thin Layer Chromatography.
13.	Estimation of Total Hardness of water by Complexometric

	Titrations.
14.	Gravimetric estimation of Iron.
15.	Gravimetric Estimation of Barium.

Course Outcomes: After completion of course students should be able to

1. Explain the Titrimetric Analysis.
2. Remember the lambert Beer's Law and use of Colorimeter.
3. Calculate the Value of Absorbance.
4. Calculate the relative strength of acids.

References:

1. Laboratory Manual for Principles of General Chemistry, J. A. beran , John Wiley and Sons, 6th edition, 2000.
2. Qualitative Inorganic Analysis, Svehla, G. Vogel's, 2012, Pearson Education.
3. A Senior Practical Physical Chemistry D. Garg V. C. and Gulati R. Chand , New Delhi, 2011.

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B. Sc. II Nanoscience and Technology Semester VI

BNTPVSC II: Thin Film Coating Techniques II

Lectures 30 Credit (2)

Objectives: Students will be able to

1. Study of Fabrication of thin layers.
2. Learn thin film coating technique
3. Study and understand the physical vapour deposition method
4. determine the Spray Pyrolysis technique

Sr. No.	List of Experiments
1.	Techniques of FTO substrate cleaning
2.	To Synthesis of MgO thin film by CVD method
3.	To Synthesis of Nickel Oxide thin film by CVD method
4.	To Synthesis of CdS thin film by CVD method
5.	To Synthesis of ZnO thin film by CVD method
6.	Deposition of Polyaniline thin film by electro deposition
7.	To Synthesis of ZnO thin film by Spray Pyrolysis method
8.	To Synthesis of TiO2 thin film by Spin Coating method
9.	To Synthesis of TiO2 thin film by Sol gel method
10.	To Synthesis of MgO thin film by PVD method

11.	To Synthesis of Nickel Oxide thin film by PVD method
12.	To Synthesis of CdS thin film by PVD method
13.	To Synthesis of ZnO thin film by PVD method
14.	To Synthesis of TiO2 thin film by dr Blade method
15.	To Synthesis of Ferrite thin film by Spray pyrolysis method
16.	To Synthesis of Nickel Oxide thin film by Spray pyrolysis Method
17.	To Synthesis of Iron Oxide thin film by Spray pyrolysis Method
18.	To Synthesis of ZnO thin film by Electro deposition
19.	To Synthesis of Ferrite thin film by Spray pyrolysis method
20.	Resistivity of thin film by two probe method

Course Outcomes: After completion of course students should be able to

1. Understand of Fabrication of thin layers.
2. Learn thin film coating technique
3. Understand the physical vapour deposition method
4. Determine the Spray Pyrolysis technique

References:

1. Prushan M. J. Instrumental Analysis Lab manual, CHM 311, 2018.
2. Charles P. Poole Jr, Introduction to Nanotechnology, Franks. J. Qwens John Wiley and Sons. 2003.
3. Ehud Gazit, Plenty of Room for Biology at the Bottom: An Introduction to Bio nanotechnology, Imperial college Press 2007.
4. Bharat Bhushan Springer Handbook of Nanotechnology, Springer Verlag 2007.
5. Kumar S. R, Challa S. S, Nanofabrication towards biomedical application: Techniques, tools, Application and impact J. H. Carola, John Wiley and Sons 2006.

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B. Sc. II Nanoscience and Technology Semester VI

BNTTSEC-III: Sensor Technology

Lectures 30 Credit (2)

Objectives: Students will be able to

1. To understand the basics of sensor technology.
2. Learn the basic parameters of sensors.
3. Understand the different types of sensors.
4. Designing of sensor.

Sr. No.	List of Experiments
1.	To study the Basics of sensors and transducers
2.	Introduction to sensors
3.	To study Materials for Sensors
4.	To understand the Multidisciplinary Aspects of sensors
5.	Introduction to sensor parameters
6.	Analysis of sensor parameters I
7.	Analysis of sensor parameters II
8.	To study properties Capacitive Sensors
9.	To study properties of thermal Sensor
10.	To study properties of Chemical Sensor
11.	To study properties optical sensor
12.	To study properties magnetic sensor
13.	Introduction of MEMS sensors
14.	Synthesis of thin film for sensor application: Case Study
15.	To study the structural properties of sensor material
16.	To study the optical properties of sensor material
17.	Parameter analysis of thin film sensor I
18.	Parameter analysis of thin film sensor II
19.	Performance analysis of thin film sensor I
20.	To study the Calibration of sensor

Course Outcomes: After completion of course students should be able to

1. Understand Basics of Sensors and Transducers
2. Identify the Types of Sensors
3. Evaluate the properties of Sensors
4. Designing of Sensor.

References:

1. Jacob Fraden, Handbook of Modern Sensors Physics, Designs and Applications Fourth edition
2. Sensor Technology Handbook, Jon Wilson

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Rayat Shikshan Sanstha's
Yashavantrao Chavan Institute of Science, Satara (Autonomous)
(Lead college of Karmaveer Bhaurao Patil University, Satara)
Cultural Committee: Co-curricular Course
Bachelor of Science (B. Sc.) Part - II

Course Name: Presentation Skills **Department: Nanoscience and technology**

Structure of the Course:

Duration	Theory Periods	Practical Periods	Total Periods	Credits	No. of Students in batch
Sem IV	30		30	**2**	

Course objectives:

Students should be able to …

1. Enhance oral communication skills.
2. Develop effective visual aids creation and utilization
3. Understand use of presentation skills for Nanotechnology
4. Create effective presentation

Credit (2)	**Name of the Unit**	**No of Hrs. (30)**
Unit I	**Introduction to Presentation Skills** 1.1 Understanding the Importance of Presentation Skills 1.2 Elements of Effective Communication 1.3 Structuring Presentations: Introduction, Body, Conclusion 1.4 Engaging the Audience: Attention-grabbing techniques 1.5 Verbal Communication: Clarity, tone, and pace 1.6 Non-verbal Communication: Body language, eye contact, and gestures	7
Unit II	**Tools and techniques for effective presentation** 2.1 Visual Aids and Slide Design 2.2 Design Principles for Slides: Simplicity, consistency, and clarity 2.3 Effective Use of Visual Aids: PowerPoint, Prezi, and other tools 2.4 Incorporating Images, Charts, and Graphs, Font Selection and Formatting Guidelines 2.5 Creating Engaging Presentations: Storytelling and narrative techniques	8
Unit III	**Presentation Skills and Nano technology** 3.1 Introduction to nanotechnology 3.2 Importance of presentation skills in Nanotechnology 3.3 Communicating concepts from nanotechnology through presentations	8

Unit IV	**Application of Presentation Skills in nanotechnology**	7
	4.1 Use of audio visual aids 4.2 Power Point presentation on nanotechnology 4.3 AI tools for effective presentation	

Course outcomes:

Students will be able to…

1. Improve their ability to articulate ideas clearly, confidently, and effectively in various academic and professional settings.
2. Learn to design and incorporate visually engaging and informative presentation slides, graphics, and multimedia elements to enhance audience understanding and engagement.
3. Create effective presentations on the topics from nanotechnology.
4. Make effective presentations on nanotechnology using various techniques.

Reference Books:

1. "TED Talks: The Official TED Guide to Public Speaking" by Chris Anderson, 2016
2. " The Presentation Secrets of Steve Jobs: How to Be Insanely Great in Front of Any Audience by Carmine Gallo, Hill Education, 2010
3. "The Presentation Secrets of Steve Jobs: How to Be Insanely Great in Front of Any Audience" by Carmine Gallo, 2010
4. Slideology: The Art and Science of Creating Great Presentations" by Nancy Duarte, 2008
5. "Presentation Zen: Simple Ideas on Presentation Design and Delivery" by Garr Reynolds, 2008