Rayat Shikshan Sanstha's

Yashavantrao Chavan Institute of Science, Satara
(Autonomous)

(Lead College, Karmaveer Bhaurao Patil University, Satara)

Syllabus under Autonomy

for

Nanoscience and Technology

B. Sc. I

As Per NEP-2020

Academic Year 2023 - 2024

B. Sc. Part I

1) **Title:** Nanoscience and Technology (Entire)
2) **Year of Implementation:** The syllabus will be implemented from June, 2023
3) **Preamble:**

B. Sc. Nanoscience and Technology (Entire) course is multidisciplinary. The goal of the syllabus is to make the study of Nanotechnology applications interesting and encouraging to the students for higher studies including research.

The new syllabus is based on a basic and applied approach with vigour and depth. At the same time precaution is taken to make the syllabus compatible to the needs of industries and research. It is prepared after discussion at length with number of faculty members of the subject and experts from industries and research fields. The units of the syllabus are well defined, taking into consideration the level and capacity of students. In general, course objectives have been framed and the curriculum and syllabus have been structured in such a way that each of the subjects meets one or more of these objectives. Student outcomes describe what students are expected to know and be able to do by the time of graduation. These relate to the skills, knowledge, and behaviors that students acquire as they progress through the course. Further each subject paper in the course spells out clear objectives and outcomes which are mapped to the student outcomes. It is expected to inspire and boost interest of the students towards applications of nanotechnology and provide skills to the students as per industry needs.

4) **Program Objective:**
   1. This course is design to develop the ability to work with multidisciplinary teams, design and conduct experiments, as well as to analyze and interpret data.
   2. To learn techniques, skills, and modern instrument tools necessary for research practices.
   3. To understand the fundamentals principles, concepts and recent developments in the subject area.
   4. This curriculum will inspire and boost interest of the students in Nanoscience to meet desired needs within realistic constraints such as economic, environmental, social, health and safety, manufacturability, and sustainability.
5) **Program Specific Outcomes:**

   After successful completion of B.Sc. Nanoscience and Technology Entire Course student will be able to:
   1. Understand the various concepts in Nanophysics, Nano-chemistry, Nanobiotechnology and able to implement it at nanoscale.
   2. Use the techniques, skills, and modern instrumental tools necessary for Research practices.
   3. Learn to design and perform experiments in the labs to demonstrate the concepts, principles and theories learned in the classrooms.
   4. Develop the ability to work with multidisciplinary approach.
   5. Identify their area of interest in academic, research and development.
   6. Perform job in various fields like Research and Development, engineering, education, business and public service, etc. or be an entrepreneur with

precision, analytical mind, innovative thinking, and clarity of thought, expression, and systematic approach.

6) **Duration:** The course shall be a full time.
7) **Pattern:** Semester examination.
8) **Medium of Instruction:** English.
9) **Structure of Course:**

B. Sc. I Semester-I

Sr. No	Subject Title	Theory				Practical		
		Paper No. & Paper Code	Title of Paper	No. of lectures per week	Credits	Title of Paper and Code	No. of lectures Per week	Credits
1.	Nanoscience and Technology (Major)	BNTT-111	Introduction to nanoscience and Nanotechnology	5	4	Practical Paper – I BNTP-113	4	2
		BNTT-112	Properties of Nanomaterials					
2.	Nanoscience and Technology (Minor)	BNTT-114	Physics for Nanoscience I	5	4	Practical Paper – I BNTP-116	4	2
		BNTT-115	Chemistry for Nanoscience I					
3.	Open Elective	BNTT-117	Introduction to earth	5	4	Practical Paper – I BNTP-119	4	2
		BNTT-118	Ecology and Ecosystem					
4.	IKS	IKS101	Indian Agriculture	3	2	--	--	--
5	CC				2			

B. Sc. I Semester-II

Sr. No	Subject Title	Theory				Practical		
		Paper No. & Paper Code	Title of Paper	No. of lectures per week	Credits	Title of Paper and Code	No. of lectures Per week	Credits
1.	Nanoscience and Technology (Major)	BNTT-121	Synthesis of Nanomaterials I	5	4	Practical Paper – II BNTP-123	4	2
		BNTT-122	Synthesis of Nanomaterials II					
2.	Nanoscience and Technology (Minor)	BNTT-124	Physics for Nanoscience II	5	4	Practical Paper – II BNTP-126	4	2
		BNTT-125	Chemistry for Nanoscience II					
3.	Open Elective	BNTT-127	Atmosphere and Climate Change	5	4	Practical Paper – II BNTP-129	4	2
		BNTT-128	Urban Ecosystems					
4.	SEC	SEC-103	UV-Vis Spectrophotometry Techniques	3	2	--	--	--
5.	VEC	VEC-104	Understanding India	2	2			

Titles of Courses B. Sc. I

B. Sc. I (Semester-I)

Theory: 30 hours (Major Course)

Course – I: BNTT 111: Introduction to Nanoscience and Nanotechnology

Course – II: BNTT 112: Properties of Nanomaterials

Practical: 60 hours (Total)

Practical Course I: BNTP 113: Practicals Based on Major Paper I and II

Theory: 30 lectures, 30 hours (Minor Course)

Course – I: BNTT 114: Physics for Nanoscience I

Course – II: BNTT 115: Chemistry for Nanoscience I

Practical: 60 hours (Total)

Practical Course II: BNTP 116: Practicals Based on Minor Paper I and II

Theory: 30 lectures, 30 hours (Open Elective Course): Environmental Studies

Course – I: BNTT 117: Introduction to earth

Course – II: BNTT 118 : Ecology and Ecosystems

Practical: 60 hours (Total)
Practical Course II: BNTP 119: Based on theory syllabus

Theory: 15 lectures, 15 hours (IKS Course)
Course – I: BNTT 101: Indian Agricultural

Theory: 15 lectures, 15 hours (CC Course)
Course – I: BNTT 102: NSS, NCC, CULTURAL, SPORT.

B. Sc. I (Semester-II)

Theory: 30 hours (Major Course)
Course – I: BNTT 121: Synthesis of Nanomaterials I
Course – II: BNTT 122: Synthesis of Nanomaterials II
Practical: 60 hours (Total)
Practical Course I: BNTP 123: Practicals Based on Major Paper I and II

Theory: 30 lectures, 30 hours (Minor Course)
Course – I: BNTT 124: Physics for Nanoscience II
Course – II: BNTT 125: Chemistry for Nanoscience II
Practical: 60 hours (Total)
Practical Course II: BNTP 126: Practicals Based on Minor Paper I and II

Theory: 30 lectures, 30 hours (Open Elective Course): Environmental Studies
Course – I: BNTT 127: Atmosphere and Climate Change
Course – II: BNTT 128 : Urban Ecosystems
Practical: 60 hours (Total)
Practical Course II: BNTP 129: Based on theory syllabus

Theory: 15 lectures, 15 hours (SEC Course)
Course – I: BNTT 103: UV-Vis Spectrophotometry Techniques

Theory: 15 lectures, 15 hours (VEC Course)
Course – I: BNTT 104: Understanding India

B. Sc. I Semester-I

BNTT 111: Introduction to Nanoscience and Nanotechnology

Course Objectives: Students should be able to…

1. Inspire and boost the interest of the students towards Nanoscience & Nanoscale Material.
2. Learn and understand the Nano effects in Nature.
3. Adopt knowledge and Prepare Nanomaterials using different Synthesis Techniques.
4. Study the Properties of various Nanomaterials

Units	BNTT 111: Introduction to Nanoscience and Nanotechnology	No. of Hours 30 (Credit: 2)
Unit I	**Origin of Nanoscience** History of Nanotechnology-Nanotechnology timeline- Pre-18th century, 19^{th} century, 20^{th} century& 21^{st} century. Basic Introduction about Nanoscience and Nanotechnology, Nanoscale effects.	06
Unit II	**Nanoscience and Nature** Scientific revolution -Atomic structure, Molecular & atomic size, Bohr's radius. Nano and Nature- Nanoscopic colors (Butterfly wings), Bioluminescence (fireflies), Tribology (Geckos sticky feet, lotus effect).	08
Unit III	**Types of Nanomaterials** Classification of Nanomaterials: 0D, 1D, 2D and 3D and types of nanomaterials (Quantum Dots, CNTs, Bucky Balls, Nanocomposites etc.) Nanoscience: Quantum mechanics, Brownian motion, surface forces, surface to volume ratio.	08
Unit IV	**Nanomaterials and Properties** Carbon nanotubes (CNTs), Metals (Au, Ag), Metal oxides (TiO_2, ZnO, CeO_2), Semiconductors (Si, Ge, Cds, ZnSe), ceramics & composites, biological system- Lipids, Size-dependent properties,(Mechanical, Physical & chemical properties).	08

Course Outcomes: Students will be able to…

1. Define nanoscience, nanotechnology, and nanoscale.
2. To know brief information about classification of nanomaterials.
3. Evaluate and apply laws and theories related to nanomaterials.
4. Analyze the properties of the nanomaterials.

Reference Books:

1. Kulkarni S. K., 2015, Nanotechnology: Principles and Practices, 3^{rd} Ed., Capital PublishingCompany.
2. Murty B. S., Shankar P., Baldev R., Rath B. B. and James M., 2013 Textbook of and Nanoscience Nanotechnology, Springer Universities Press (India) Private Limited.
3. Hornyak G. L., Tibbals H.F., Dutta J., Moore J.J., 2009, Introduction to Nanoscience and Nanotechnology (CRCPress, Boca Raton)

4. Wilson M., Kannangara K., Smith G., Raguse M. B., Raguse, 2005, Nanotechnology: Basic science andEmerging technologies, 1st Ed., Overseas Press India Pvt Ltd, New Delhi.
5. Cao G., 2004, Naostructures and Nanomaterials: Synthesis, properties and applications, Imperical CollegePress.

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B. Sc. I Semester I
BNTT 112 - Properties of Nanomaterials

Course Objectives: Students should be able to…

1. Learn the Different Properties of Nanomaterials.
2. Study the Mechanical, Optical, Electrical and Magnetic Properties of Nanomaterials in detail.
3. Describe the Band Structure based Classification of Materials.
4. Analyze Various Properties of Nanomaterials.

Units	BNTT 112 - Properties of Nanomaterials	No. of Hours 30 (Credit: 2)
Unit I	**Mechanical Properties** Stress, strain, elastic properties, modulus of elasticity Poisson's ratio and relationship between moduli (qualitative), yield strength, stress-strain diagram for ductile and brittle materials, uses -factors affecting elastic modulus and tensile strength, toughness, elongation, plastic deformation, hardness, impact strength, creep, fatigue, ductile and brittle fracture.	08
Unit II	**Optical Properties** Reflection, refraction, diffraction of light, absorption and transmission of electromagnetic radiation in solids. Photoelectric emission, photoconductivity and photoluminescence.	06
Unit III	**Electrical Properties** Concept of energy band diagram for materials - conductors, semiconductors and insulators, Intrinsic Semiconductors, direct and indirect band gap semiconductors, extrinsic semiconductors, N- type and P –type semiconductor.	08
Unit IV	**Magnetic Properties** Origin of magnetism in materials, para-magnetism, diamagnetism, anti-ferromagnetism, ferromagnetism, ferrimagnetism, magnetic hysteresis. Ferromagnetic domains. Soft and hard magnetic materials. Measurement of magnetic susceptibility. Applications of magnetic materials.	08

Course Outcomes: Students will be able to…

1. Define different Terms related to Properties of Nanomaterials.
2. Explain Mechanical, Optical, Electrical and Magnetic Properties of Nanomaterials.
3. Demonstrate different Types of Semiconductors.

4. To know brief information about the Different Properties of Nanomaterials.

Reference Books:

1. Gavrilenko V. I., 2020, Optics of Nanomaterials, 2nd Ed., Jenny Stanford Publishing Pt. Ltd.
2. Kulkarni S. K., 2015, Nanotechnology: Principles and Practices, 3rd Ed., Capital Publishing Company.
3. Murty B. S., Shankar P., Baldev R., Rath B. B. and James M., 2013,Textbook of and Nanoscience Nanotechnology, Springer Universities Press (India) Private Limited.
4. William D., Callister J. R., Rethwisch D. G.,2013, Materials Science and Engineering and Introduction willey Printed in the United States of America.
5. T. Pradeep., 2012, Textbook of Nanoscience and Nanotechnology McGraw Hill Education (India) Private Limited.

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B. Sc. I Semester I
BNTP 113: Practical Course I– Lab I

Course Objectives: Students should be able to…

1) Demonstrate the Nano Effects in Nature
2) Learn handling of Sophisticated Equipment used in Laboratory.
3) Study and understand the Nano effects presents in nature.
4) Evaluate the Properties of Nanomaterials.

Sr. No.	Title of the Experiments	No. of Hours (Credit-02)
1.	To Identify the Nano Effects in the Nature.	02
2.	To study the Classification of Nanomaterials.	02
3.	Introduction to lab equipment I: Weighing balance, pH & Conductivity meter, Colorimeter, Potentiometer, Centrifuge, Hot Air Oven, Autoclave, Muffle Furnace, Distillation unit, Sonicator.	02
4.	Introduction to lab equipment II: a) Measurement of pH and Conductivity. b) Use of Colorimeter and Potentiometer.	02
5.	Measurement of Surface to Volume Ratio.	02
6.	Young's Modulus of Material of Bar by Vibration.	02
7.	Poisson's Ratio for Rubber using Rubber Tube.	02
8.	Measurement of Transmittance and Absorbance of Nanomaterials.	02
9.	Diffraction due to Single slit using Sodium / Laser Source.	02

10.	To Investigate the Relationship between the Angle of Incidence (i) and the Angle of Refraction (r)	02
11.	To Determine the Refractive Index of a Transparent Solid Medium e.g. Glass.	02
12.	To study the Characteristics of the Forward and Reverse Biased Junction Diode.	02
13.	To Determine the Energy Band Gap of a Semiconductor by using PN Junction Diode.	02
14.	Determination of thermal conductivity of a Bad Conductor. (Lee's disc)	02
15.	To study Faradays Magnetic Field Induction.	02

Course Outcomes: Students will be able to…

1. Use Sophisticated Equipment used in Laboratory.
2. Describe and Demonstrate the Nano Effects Presents in Nature.
3. Analyze Bandgap of Semiconductor Material.
4. Apply the Basic Laws of Science to Study the Magnetic and Optical Properties of Materials.

Reference Books:

1) 2017, Department of Science Faculty of Science and Technology, National Institute of Education PHYSICS Practical Handbook.
2) Kulkarni S. K., 2015, Nanotechnology: Principles and Practices, 3rd Ed., Capital Publishing Company.
3) T. Pradeep. 2012, Textbook of Nanoscience and Nanotechnology, McGraw Hill Education (India) Private Limited.

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B. Sc. I Semester- I

BNTT 114: Physics for Nanoscience I

Course Objective: Students should be able to …

1. Inspire and boost the interest of the students towards angle of contact.
2. Understand types of oscillation.
3. Adopt knowledge about bending of beam.
4. Evaluate the concept of viscosity.

Units	BNTT 114: Physics for Nanoscience I	No. of Hours 30 (Credit: 2)
Unit I	**Crystal Structure and their Properties** Atomic structure, Atomic Bonding in solid, Unit cells and space lattice, Crystal structure, Crystal planes and direction, Miller Indices, Diffraction of X-ray by crystal, Bragg's equation, Reciprocal lattice, Crystal defect point	08
Unit II	**Surface Tension** Surface tension, Angle of contact and wettability, Relation between surface tension, Excess of pressure and radius of curvature, Application of surface tension, Hydrophobic and Super hydrophobic nanostructure, surface determination of surface tension by jaeger's method.	08
Unit III	**Elasticity** Introduction, bending of beam and Bending moments, Cantileverbeam supported at both end, bending of beam fixed at one end.	06
Unit IV	**Fluid Dynamics and Viscosity** Introduction, General concept of fluid flow, viscous fluid, Experimental determination of coefficient of viscosity of liquid by Poiseuille's capillary flow method, Effect of Temperature andpressure on viscosity of liquid	08

Course Outcomes: Students will be able to…

1. Define atomic structure and unit cell.
2. Explain classification of crystal structure.
3. Learn the application of surface tension.
4. Analyze the effect of temperature and pressure on viscosity of liquid.

Reference Books-

1. Ketterson. B. J**.** September 2016.The Physics of Solids. Oxford University.
2. Matthew E. Cross, Emma V. E. Plunkett. June 2014. Physics,Pharmacology and Physiology for Anaesthetists.
3. Wing Kam Liu, Eduard G. Karpov, Harold S. Park. 2006. Nano Mechanics and Materials: Theory, MultiscaleMethods and Applications. England: John Wiley & Sons.
4. Dr. Dhaygude. N. S. Prof. Karve. S.R. Prof. Gidavir. S.S. Prof. Jadhav. K.D. Nandurker. R.D. November 2003.A Textbook of Physics. First edition.
5. Cleland. N. Andrew. 2003. Foundations of Nanomechanics: From Solid – State Theory to DeviceApplications. Springer International Edition. Verlag, New York.

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B. Sc. I Semester I

BNTT 115: Chemistry for Nanoscience I

Course Objectives: Students should be able to…

1. Learn the principles of fundamental organic chemistry and industrials chemistry.
2. Study theories and concept about acid and bases.
3. Remember order of reaction.
4. Understand physical properties of liquids.

Units	**BNTT 115: Chemistry for Nanoscience I**	**No. of Hours 30 (Credit: 2)**
Unit I	**General Concepts in Chemistry** Introduction, Definition and Explanation of the following terms- Solute, Solvent, Solution, Polar solvent, Non-Polar solvent, Saturated solution, Unsaturated solution, Supersaturated solution, Normality, Equivalent weight, Molecular weight, Molarity, Percentage solution, ppt, ppm, ppb solutions, Mole Fraction, Weight fraction, Problems based on Normality, Molarity, mole fraction, mixed solution.	06
Unit II	**Acid and Bases** Introduction, Concept of pH, Acid, Base, Acidity of the base, Basicity of acid, pH scale, Neutralization, Arrhenius concept, Bronsted lowery concept, Lewisconcept, Lux-Flood Concept	08
Unit III	**Physical Properties of Liquids** Introduction & Classification of Physical Properties Surface Tension and Chemical Constitution, Viscosity Refractive Index (Snell's law) Specific and Molecular Refractivity's, Molecular Refractivity and Chemical Constitution	08
Unit IV	**Chemical Kinetics** Introduction, Rate of Constant or Specific Reactions Rate, Order and Molecularity of Reaction, First order Reactions, Pseudounimolecular Reactions, Second Order Reactions	08

Course Outcome: Students will be able to…

1. Define molarity and normality.
2. Explain bronsted lowery concept.
3. Learn the chemical kinetics and psedounimolecular reaction.
4. Analyze the physical properties of surface tension.

Reference Books-

1. Clayden Jonathan. Greeves Nick. 2014. Stuart Warren Organic Chemistry. 2nd Edition. Oxford Publisher.
2. Brian G. Cox. 2013. Acids and Bases Solvent Effects on Acid–Base Strength. Oxford University Press.
3. Ahluwalia V.K. 2011. Organic Reaction Mechanism. 4th Edition. Naroso Publishing House.
4. Laidler. K. J. 2004. Chemical Kinetics. India: Pearson Education.
5. Atkins. P. W. 2002. Physical Chemistry. 7th edition. Oxford University press.

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B. Sc. I Semester: I

BNTP 116: Practical Course I – Lab I

Course Objectives: Students should be able to…

1. Demostrate the basic principles and effects in physical sciences.
2. Learn the basic principles and effects in chemical sciences.
3. Describe and understand the instrumental and non – instrumental experiments.
4. Acquire laboratory instruments handling skills.

Sr. No.	Title of the experiments	No. of Hours/ (Credit-02)
1.	Preparation of Standard Solution	02
2.	To determine the heat of ionization of a weak acid by using polythene bottle.	02
3.	To investigate the reaction between potassium per sulphate and potassium iodide withequal initial concentration of reactants.	02
4.	To determine equivalent weight of metal (mg) by hydrogen displacement method usingEudiometer	02
5.	To determine the energy of activation for a first order reaction of hydrolysis of methylacetate in presence of 0.5 N HCL/ 0.5 N H_2SO_4	02
6.	Preparation of buffer solutions: a. Sodium acetate-acetic acid. b. Ammonium chloride-ammonium hydroxide. Measurement of the pH of buffer solutions and comparison of the values with theoretical Values	02
7.	Determination of enthalpy of neutralization of hydrochloric acid with sodium hydroxide	02
8.	Surface tension by ripple method	02
9.	Determination of crystalline size using Scherer's formula	02
10.	To determine Youngs modulus (Y) of a wooden bar.	02
11.	To determine the contact angle.	02
12.	Viscosity by Poiseuille's method.	02
13.	Determination of the surface tension of a liquid by Jaeger's method.	02
14.	Determination of the lattice constant by using Scherrer formula.	02
15.	Determine the surface tension of a given liquid at room temp using stalgomometer by drop number method	02

Course Outcomes: Students will be able to…

1. Use sophisticated equipment used in laboratory.
2. Evaluate surface tension by different methods.
3. Analyze contact angle.
4. Apply scherrer formula for determination of crystalline size and lattice constant.

Reference Books-

1. Department of Science Faculty of Science and Technology National Institute of Education PHYSICS Practical Handbook.2017.
2. Hannaford B. S. Smith A. J. Tatchell P.W. 2012. Practical Organic Chemistry. 5th Edition.
3. Lechtanski Valerie Ludwig. 2000. Inquiry-based Experiments in Chemistry. Oxford University.

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Syllabus for Open Elective Course
ENVIRONMENTAL STUDIES

B. Sc. I Semester: I
BNTT 117 - Introduction to Earth

Units	BNTT-117 Introduction to Earth	No. of Hours (Credit-02)
Unit I	**Origin of Earth-** • Formation of the Earth, • Chemical composition of Earth, • Geological time scale, • Concept of plate tectonics, • Gravitational and magnetic fields of the earth .	06
Unit II	**Rocks and Its formation-** • Important rock forming minerals, • Rock cycle, • Rock structure, igneous, sedimentary and metamorphic rocks, • Weathering of Rock, • Rock Erosion, • Factors and gents of erosion.	08
Unit III	**Processes of Earth surface-** • Evolution of earth's atmosphere, • Composition of atmosphere, • Atmosphere - Ocean interface and Land interface, • Rivers and geomorphology.	08
Unit IV	**Importance of mountain-** • Formation of Indian mountains, • Formation of the Himalaya • Perennial river, • Evolution of monsoon in Indian, • Evolution of Indus Valley civilization; • Progression of agriculture in the Indian subcontinent.	08

Reference Books:

1. Bridge, J. & Demicco, R. 2008. Earth Surface Processes, Landforms and Sediment deposits. Cambridge University Press.
2. Pelletier, J. D. 2008. Quantitative Modeling of Earth Surface Processes (Vol. 304). Cambridge: Cambridge University Press. Chicago
3. Gupta, A. K., Anderson, D. M., Pandey, D. N., & Singhvi, A. K. 2006. Adaptation and human migration, and evidence of agriculture coincident with changes in the Indian summer monsoon during the Holocene. Current Science 90: 1082-1090.
4. Leeder, M., & Arlucea, M.P. 2005. Physical Processes in Earth and Environmental Sciences.Blackwell Publishing.
5. Gupta, A. K., Anderson, D. M., & Overpeck, J. T. 2003. Abrupt changes in the Asian southwest monsoon during the Holocene and their links to the North Atlantic Ocean. Nature 421: 354-357.
6. Duff, P. M. D. and Duff, D. (Eds.). 1993. Holmes' Principles of Physical Geology. Taylor & Francis.
7. Keller, E.A. 2011. Introduction to Environmental Geology (5th edition). Pearson Prentice Hall. • Krishnan, M. S. 1982. Geology of India and Burma. CBS Publishers & Distributors.

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B. Sc. I Semester: I

BNTT 118 - Ecology and Ecosystems

Units	BNTT-118 Ecology and Ecosystems	No. of Hours (Credit-02)
Unit I	**General concepts of Ecology-** • General Concepts: ecology and ecosystems • Major terrestrial biomes, • Decomposition and nutrient release , • Thermoregulation; Strategies of adaptation in plants and animals.	06
Unit II	**Ecosystem Connections-** • Food chain, • Food web, • Detritus pathway of energy flow, • Ecological pyramids, • Nutrient supply and uptake.	08
Unit III	**Biogeochemical cycles-** • Carbon cycle, Nitrogen cycle, Hydrological cycle, Nutrient cycle models, • Biotic accumulation, • Nutrient supply and uptake, • Role of mycorrhizae, • Decomposition and nutrient release; • Biological invasions: natural versus man-induced invasions.	08
Unit IV	**Ecosystem-** • Ecosystem structure and functions,	08

	• Forest, grassland, lentic, lotic, estuarine, marine, desert, wetlands, • Abiotic and biotic components of ecosystem.	

Reference Books:

1. Pandit, M.K., White, S.M.& Pocock, M.J.O. 2014. The contrasting effects of genome size, chromosome number and ploidy level on plant invasiveness: a global analysis. New Phytologist203: 697-703.
2. Pimentel, D. (Ed.). 2011. Biological invasions: Economic and environmental costs of alien plant, animal, and microbe species. CRC Press.
3. Singh, J.S., Singh, S.P. & Gupta, S.R. 2006. Ecology, Environment and Resource Conservation. Anamaya Publications.
4. Groom. B. & Jenkins. M. 2000.Global Biodiversity: Earth's Living Resources in the 21stCentury. World Conservation Press, Cambridge, UK.
5. Gurevitch, J., Scheiner, S. M., & Fox, G. A. 2002. The Ecology of Plants. Sinauer associates incorporated.
6. Loreau, M. & Inchausti, P. 2002. Biodiversity and Ecosystem functioning: Synthesis and Perspectives. Oxford University Press, Oxford, UK.
7. Wilson, E. O. 1985. The Biological Diversity Crisis. Bio Science 35: 700-706.

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B. Sc. I Semester: I

BNTT 119 – Environmental Studies Practical Course

B. Sc. I (Nanoscience and Technology) Semester I

BNTT 101 (IKS) : Indian Agriculture

Course objectives:

1) To impart knowledge of traditional agricultural practices followed in India.
2) To develop awareness about the glorious history of Indian agriculture.
3) To make the students knowledgeable about ancient agricultural techniques.
4) To empower the students with the ability to compare ancient, medieval, and modern agriculture trends.

Units	Semester I IKS 101-Indian Agriculture	Lectures 30 Credits 02
Unit I	**History of Indian Agriculture** • Introduction and importance of Agriculture in India • History of Indian agriculture: The significance of agriculture and irrigation as emphasized in the Ramayana, Mahabharata, and other texts, • Mention of Indian agriculture by Greek historians and later travellers	08
Unit II	**Ancient Irrigation Techniques** • Significance of Agriculture and irrigation for the Kings of Indian tradition. • Major water bodies of ancient times. • The Ery system of south India.	07
Unit III	**Indian Agriculture Technologies** • Excellence of Indian agricultural technologies as observed by more recent European observers. • Productivity of Indian agriculture in medieval Thanjavur and eighteenth-century Allahabad, Chengalpattu, etc.	08

Course Outcomes:

After completion of this course students will be able to:

1. Tell about ancient Indian agriculture and compare the different ancient agriculture traditions with the current scenario.
2. Explain the irrigation techniques in India and demonstrate the various irrigation techniques followed in India.
3. Evaluate the effectiveness of different agriculture technologies implemented in India.
4. Compare the Indian attitude towards agriculture during the history of India.

Reference Books:

1. Basu, R. N., Bose, T. K., Chakraborty, C. S. (2017). History of Science in India - Agricultural Science (Volume V). The National Academy of Science, India (NASI) & The Ramakrishna Mission Institute of Culture, India.
2. Bunce, F. W (2013).The Iconography of Water: Well and Tank Forms of the Indian Subcontinent.. D. K. Printworld Pvt. Ltd., New Delhi.

3. Chakravarty, K. K., Badam, G. L., Paranjpye, V. (2006), Traditional Water Management Systems of India. Aryan Books International, New Delhi.
4. Ayangarya, V. S. (2006), Lokopakara (For the Benefit of People) - An Ancient Text on Indian Agriculture Asian Agri-History Foundation, India.
5. Mukundan, T. M. Akash Ganga Trust, (2005), The Ery Systems of South India. Chennai.
6. Bhadani, B. L.(2002),Water Harvesting, Conservation and Irrigation in Mewar (AD 800-1700). Manohar Publishers & Distributors, New Delhi.
7. Agarwal, A., Narain, S. (1997).Dying Wisdom: Rise, Fall and Potential of India Traditional Water-Harvesting Systems. Centre for Science and Environment, New Delhi.
8. Srinivasan, T. M. (1991).Irrigation and Water Supply: South India, 200 BC to 1600 AD. South Asia Books, Hyderabad.

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B. Sc. I Semester II
BNTT 121 – Synthesis of Nanomaterials I

Course Objectives: Students should be able to…

1. Study the basics of nanomaterials synthesis.
2. Understand the physical methods of nanomaterials synthesis.
3. Describe advantages and disadvantages of physical methods of nanoparticle synthesis.
4. Learn the biological methods of nanoparticle synthesis.

Units	**BNTT 121 – Synthesis of Nanomaterials I**	**No. of Hours 30 Credit (02)**
Unit I	**Basics of Synthesis Method** Introduction: Factors affecting synthesis of nanoparticles, Top down and Bottom up approach, Classification of synthesis methods (Physical, Chemical and Biological method).	**08**
Unit II	**Physical Synthesis: Mechanical Method** Introduction, Mechanical method: Working, Principle, Advantages and Disadvantages of (Ball milling, Melt mixing).	**06**
Unit III	**Physical Synthesis: Evaporation Method** Introduction, Physical Vapor Deposition: Introduction, advantages and disadvantages, Sputtering Deposition: Introduction, advantages and disadvantages.	**08**
Unit IV	**Biological Synthesis** Introduction, Green synthesis of nanoparticles, Advantages and disadvantages, Synthesis of nanoparticles by bacteria, synthesis of nanoparticles by fungi, Advantages and disadvantages, Application of biological method.	**08**

Course Outcomes: Students will be able to…

1. Describe the top down and bottom up approaches of nanoparticle synthesis
2. Explain physical methods of nanoparticle synthesis
3. Discuss the advantages and disadvantages of physical methods of nanoparticle synthesis.
4. Understand the biological synthesis approach of nanomaterials.

Reference Books:

1. Zhypargul Abdullaeva.2017.Synthesis of Nanoparticles and Nanomaterials Biological Approaches Springer Nature.
2. Gérrard Eddy Jai Poinern. 2015. A Laboratory Course in Nanoscience and Nanotechnology CRC Press,.Tylor and Francis Group .
3. Kulkarni.Sulabha. K. 2015. Nanotechnology: Principles and Practices.3rd ed. Capital Publishing Company.
4. Boca Raton, Kuno M. (2012), Introductory Nanoscience: Physical and Chemical Concepts, CRC Press, Tylor and Francis Group.
5. Boca Raton, Hornyak, G. L, Tibbals. H. F, Dutta. J. and Moore J. J. (2009) Introduction to Nanoscience and Nanotechnology, CRC Press, Tylor and Francis Group.

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B. Sc. I Semester II
BNTT 122 – Synthesis of Nanomaterials II

Course Objectives: Students should be able to…

1. Study the chemical methods of nanomaterials synthesis.
2. Understand the gaseous phase deposition of nanomaterials synthesis.
3. Describe the liquid phase deposition techniques of nanomaterials synthesis.
4. Describe advantages and disadvantages of chemical methods of nanoparticle synthesis.

Units	BNTT 122 – Synthesis of Nanomaterials II	No. of Hours 30 Credit (02)
Unit I	**Chemical Synthesis: Colloidal Technique** Introduction: colloids and colloids in solution, synthesis of colloid, nucleation and growth mechanism	**06**
Unit II	**Chemical Synthesis: Gas Phase Deposition Technique** Chemical Vapor Deposition: Introduction, use and application, classification of CVD process, Characteristics of CVD coating, CVD apparatus, Advantages and Disadvantages	**08**
Unit III	**Chemical Synthesis: Liquid Phase Deposition Technique I** Sol gel process: Introduction, Sol gel technique, Advantages and Disadvantages, applications. Spray Pyrolysis: Introduction, Advantages and Disadvantages, applications.	**08**
Unit IV	**Chemical Synthesis: Liquid Phase Deposition Technique II** Electrodeposition: Introduction, Advantages and Disadvantages, Applications Hydrothermal, Solvothermal: Introduction, Advantages and Disadvantages, Applications, Chemical Bath Deposition Technique, SILAR Method.	**08**

Course Outcomes: Students will be able to…

1. Define the terminologies in chemical synthesis techniques.
2. Explain the CVD method in detail.
3. Describe the liquid phase deposition techniques of nanomaterials synthesis.
4. Apply the chemical methods for nanomaterial synthesis.

Reference Books:

1. Kulkarni.Sulabha. K. 2015.Nanotechnology: Principles and Practices.3rd ed. Capital PublishingCompany.
2. Poinern Gérrard Eddy Jai. 2015.A Laboratory Course in Nanoscience and Nanotechnology CRC Press, Tylor and Francis Group.
3. Pradeep.T. 2012.Textbook of Nanoscience and Nanotechnology McGraw Hill Education (India) Private Limited.
4. Cao.G, 2004.Naostructures and Nanomaterials: Synthesis, Properties and Applications. Imperical CollegePress.
5. BocaRaton, Hornyak.G.L, Tibbals.H.F, Dutta. J.and Moore.J.J. (2009), Introduction to Nanoscience and Nanotechnology. CRC Press.Tylor and Francis Group.
6. Vladimir Pokropivny Rynno Lohmus Irina Hussainova Alex Pokropivny Sergey Vlassov. 2007. Introduction to nanomaterials and nanotechnology Tartu University Press.

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B. Sc. I Semester II
BNTP 123: Practical Course II– Lab II

Course Objectives

1. Get the practical skill of handling various instrument
2. To understand the chemical approach of nanomaterial synthesis
3. To learn the biological synthesis method using various biological materials.
4. To synthesis thin films using various chemical methods.

Sr. No.	Title of the Experiments	No. of Hours (Credit-02)
1.	Techniques of Glass/FTO/ITO/Aluminum substrate cleaning.	02
2.	Synthesis of CdS Nanoparticles by Co-precipitation method.	02
3.	Synthesis Nikel Oxide thin film preparation by SILAR method.	02
4.	Synthesis of Zinc oxide nanoparticles by Chemical Reduction method.	02
5.	Synthesis of Nikel nanoparticle by Electrodeposition method.	02
6.	Synthesis of Copper nanoparticle by using plant extraction.	02
7.	CdS thin film deposition by CBD method.	02
8.	Biological synthesis of Iron oxide nanoparticles.	02
9.	To Synthesis of MgO thin film by SILAR Technique.	02
10.	Synthesis of NiO nanoparticle by Hydrothermal method.	02
11.	Synthesis of CdS nanoparticle by Fungi.	02
12.	Synthesis of Pt nanoparticle by bacteria.	02
13.	Biosynthesis of silver nanoparticles using plant leaves extract.	02
14.	Synthesis of Zinc oxide thin film by spray pyrolysis technique	02
15.	Synthesis of Ferrite (Fe2O3)nanomaterial by Solvothermal technique	02

Course Outcomes: Students will be able to…

1. Understand the physical, chemical and biological approach of nanomaterial synthesis.
2. Prepare nanoparticles by using various methods.
3. Prepare thin films of various materials by using chemical route.
4. Handling various instrument of nanomaterial synthesis.

Reference Books:

1. Abdullaeva Zhypargul.2017.Synthesis of Nanoparticles and Nanomaterials Biological Approaches Springer Nature.
2. Vladimir Pokropivny Rynno Lohmus Irina Hussainova Alex Pokropivny Sergey Vlassov. 2007. Introduction to nanomaterials and nanotechnology. Tartu University Press
3. Cao.G.2004.Naostructures and Nanomaterials: Synthesis, Properties and Applications. Empirical College Press.

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B. Sc. I Semester II
BNTT 124: Physics for Nanoscience II

Course Objectives: Students should be able to…

1. Understand the wave nature of particles.
2. Remember atomic structure of materials.
3. Adopt knowledge about spin orbit coupling and normal Zeeman effect.
4. Learn and understand basics of molecular physics.

Units	BNTT 124: Physics for Nanoscience II	No. of Hours 30 (Credit: 2)
Unit I	Particle properties of waves: Black body radiation, Photoelectriceffect, Compton Effect. Wave properties of particles: De Broglie waves, Wave description, Particle diffraction, Uncertainty principle and application of uncertainty principle.	06
Unit II	Atomic structure: Electron orbits, The Bohr atom. Quantum Structure: 2D (Quantum well), 1D (Quantum Wires), 0D (Quantum Dots). Quantum mechanics: Schrodinger equation (steady state form), Particle in a box, Finite potential well, potential Barrier.	08
Unit III	Schrodinger approach for the hydrogen atom, Quantum numbers:principal, orbital and magnetic, Electron probability density, Radiative transitions, Selection rules, Normal Zeeman effect, Degeneracy of Hydrogen atom energy levels, Spin Orbit coupling.	08
Unit IV	Molecular Physics: molecular bond, mechanism of covalent bond,H_2^+ molecular Ion, Molecular Spectra, Rotational, Vibration Levels, Raman Spectrum, Size dependent physical, chemical, optical and magnetic properties.	08

Course Outcome: Students will be able to…

1. Understand various properties of wave.
2. Explain quantum structure.
3. Learn Schrodinger appproach for the hydrogen atom.
4. Analyze molecular spectra.

Reference Books:

1. Puri B. R. Pthania Madan .S. Sharma L. R. 2019. Principal of physical chemistry. 47th Edition.
2. Luciano Colombo. September 2019. Atomic and Molecular Physics, University of Cagliari.
3. William D. Callister. David J.R. Rethwisch G.(2018) Materials Science and Engineering An Introduction willey Printed. United States of America
4. Wing Kam Liu, Eduard G. Karpov, Harold S. Park. 2011. Nano Mechanics and Materials

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B. Sc. I Semester: II
BNTT 125: Chemistry for Nanoscience I

Course Objectives: Students will be able to…

1. Learn surface chemistry and interfacial phenomena.
2. Understand the process of distillation.
3. Adopt knowledge about analysis of samples.
4. Evaluate gravimetric estimation.

Units	BNTT 125: Chemistry for Nanoscience I	No. of Hours 30 (Credits: 2)
Unit I	**Surface Chemistry and Interfacial Phenomena:** Absorption, Adsorption isotherm, Sols, Gels, Emulsions, Micro emulsions, Micelles, Aerosols, Effect of surfactants, Hydrotropes Catalysis: Introduction, Types, Basic principles	08
Unit II	**Unit Operations** Introduction Distillation, Recrystallization, Filtration, Sublimation, (Phase Transition) Drying, Utilities in industry (Fuels, Boilers, Water, Steam, Air), Melting Point, Boiling Point.	06
Unit III	**Introduction to Analytical Chemistry** Introduction Importance of Analysis Analytical Process (Qualitative and Quantitative), Classification of Analysis Sampling of Solids, Liquids and Gases & Errors Types of Errors (Determinate and Indeterminate Errors) Methods of Expressing Accuracy (Absolute and Relative Errors) Significant Figures Mean, Median, Standard Deviation	08
Unit IV	**Gravimetry** Introduction Precipitation Nucleation Crystal Growth Digestion or Ageingor Ostwald Ripening conditions for Good Precipitation Physical Nature of Precipitate Organic Precipitants in Gravimetric Analysis Exercises.	08

Course Outcomes: Students will be able to…

1. Define qualitative and quantitative analysis.
2. Explain types of error.
3. Learn the concept of filtration and sublimation.
4. Analysis concept of Precipitation, Nucleation, Crystal Growth and Digestion.

Reference Books-

1. Chatwal Gurdeep. R. Sham K. Aug 2016. Instrumental Methods of Chemical Analysis. Anand Himalaya Publishing.
2. Sharma B. K. 2011. Industrial chemistry. 1st edition. Goel Publishing Housing.
3. Khopkar S. M. 2009. Basic Concepts of Analytical Chemistry. New Age. International Publisher.
4. Sethi Arun. 2006. Systematic Experiment in Chemistry. New Age International Publisher.

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B. Sc. I Semester: II
BNTP 126: Practical Course II – Lab II

Course Objectives: Students should be able to…

1. Learn the practical skill of handling various instrument
2. Understand the Sci lab software.
3. Evaluate chemical oxygen demand in waste water.
4. Analyze quantitative analysis of organic compound.

Sr. No.	Title of the experiments	No. of Hours (Credits: 2)
1.	Huygens's principle in water waves.	02
2.	To determine the wavelength of a given monochromatic light by investigating thediffraction pattern by a straight edge.	02
3.	To study the photoelectric effect, variations of photocurrent versus intensity andwavelength of light.	02
4.	Sci lab Experiment I (Problem from quantum mechanics)	02
5.	Sci Lab Experiment II (Problem from quantum mechanics)	02
6.	Diffraction due to single slit using sodium/ Laser source.	02
7.	Construction of the I-V curve for a forward biased semiconductor diode	02
8.	Determination of total hardness of water.	02
9.	Determination of chemical oxygen demand (COD) of industrial wastewater sample	02
10.	Quantitative analysis of organic compound	02
11.	Preparation mechanism of various reactions involved to be discussedrecrystallization.	02
12.	Determination of melting point and calculation of quantitative yieldto be done	02
13.	To Study of molarity of benzoic acid in water.	02
14.	To determine melting point of given solid sample.	02
15.	To determine boiling point of given liquid sample.	02

Course Outcomes: Students will be able to…

1. Know measuring skills in practical.
2. Understand practical concepts by performing experiments.
3. Analyze the industrial practices.
4. Handle various instruments.

Reference Books-

1. Panigrahi S. Mallick B. 2015. engeneering practical physics. Cengage learning India Pvt. Ltd.
2. Indu Prakash and Ramkrishna, Kitaab mahal, 2011. A textbook of practical physics. 11th edition.
3. Beran J .A. 2000. Laboratory Manual for Principles of General Chemistry. 6th Edition.

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Syllabus for Open Elective Course
ENVIRONMENTAL STUDIES

B. Sc. I Semester: II
BNTT 127- Atmosphere and Climate Change

Units	BNTT-127 Atmosphere and Climate Change	No. of Hours (Credit-02)
Unit I	**Atmosphere and energy balance** • Structure of atmosphere, • Climate: air and sea interaction, • Tropical cyclone, • Climate changes its impact on agriculture, • Earth's energy balance; energy transfers in atmosphere.	06
Unit II	**Meteorology and atmospheric stability** • Meteorological parameters (temperature, relative humidity, wind speed and direction, precipitation; • Atmospheric stability and mixing heights; temperature inversion; plume behavior; • Atmospheric water; role of hydroxyl and hydroperoxyl radicals in atmosphere.	08
Unit III	**Climatic Change And it's Impacts** • Recent Trends of climate change, • Impact of climate change on atmosphere, weather patterns, • Sea level rise, • Agricultural productivity, • Impact on economy and spread of human diseases.	08
Unit IV	**Ozone layer depletion** • Ozone layer or ozone shield; • Importance of ozone layer; • Ozone layer depletion and Its Impact • Effects of ozone depletion; mitigation measures and international protocols.	08

Text Books:

1. Hardy, J.T. 2003. Climate Change: Causes, Effects and Solutions. John Wiley &Sons.
2. Harvey, D. 2000. Climate and Global Climate Change. Prentice Hall.

Reference Books:

1. Maslin, M. 2014. Climate Change: A Very Short Introduction. Oxford Publications.
2. Philander, S.G. 2012. Encyclopedia of Global Warming and Climate Change (2nd edition). Sage Publications.
3. Manahan, S.E. 2010. Environmental Chemistry. CRC Press, Taylor and Francis Group.

4. Mathez, E.A. 2009. Climate Change: The Science of Global Warming and our Energy Future. Columbia University Press.
5. Gillespie, A. 2006. Climate Change, Ozone Depletion and Air Pollution: Legal Commentaries with Policy and Science Considerations. Martinus Nijhoff Publishers.
6. Mitra, A.P., Sharma, S., Bhattacharya, S., Garg, A., Devotta, S. &Sen, K. 2004. Climate Change and India. Universities Press, India.
7. Barry, R. G. 2003. Atmosphere, Weather and Climate. Routledge Press, UK.

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B. Sc. I Semester: II
BNTT 128- Urban Ecosystems

Units	BNTT-128 Urban Ecosystems	No. of Hours (Credit-02)
Unit I	**Urban Setting and Environment** • Introduction to urbanization; • Urbanization and associated environmental issues, • Role of Man in urban ecosystem; • Cities and towns as sources, • Urban pollution (air, water, soil).	06
Unit II	**Urban Residence** • Town planning and their environmental aspects; • Poverty and slums in an urban area, • Energy consumption and waste disposal , • Challenges associated with sustainability, • Urban future.	08
Unit III	**Natural spaces in a city** • Scope, importance and threats to nature in the city, • Organization and planning of green spaces, • Urban natural forest ecosystem as green lungs.	08
Unit IV	**Urban Planning and environmental management** • Benefits of environmental management; • Introduction to green buildings; • Role of urban governance.	08

Reference Books:

- Richter, M. & Weiland, U. (ed.). 2012. Applied Urban Ecology. Wiley-Blackwell, UK.
- Gaston, K.J. 2010. Urban Ecology. Cambridge University Press, New York.

B. Sc. I Semester II

BNTT 103 (SEC): UV-Vis Spectroscopy Techniques

Course objective:

1. To learn basic Instrumentation of UV-Vis Spectrophotometer.
2. To understand the basic terminologies used in UV-Vis Spectrophotometer.
3. To study the analysis of UV – Vis spectra.
4. To interpret the result of UV –Vis spectra.

Units	SEC-103 : UV-Vis Spectroscopy Techniques	Lectures (15) (Credits: 1)
Unit I	**Introduction of UV-Vis Spectrophotometer**	08
	Introduction, Principle, Working, Types of UV radiation rays Absorption, intensity shift, UV spectrum, types of absorptionbands	
Unit II	**Advances in UV-Vis Spectrophotometer**	07
	Advantages of UV vis spectrophotometer, disadvantages ofUV vis spectrophotometer, limitation, importance, application, terms for spectroscopy	

Course Outcomes:

After completion of this course students will be able to

1. Understanding the working of UV-Vis Spectrophotometer.
2. Analyze the transmission and absorption spectra.
3. Interpret the results for given

Reference Books:

1. Birasdar R. S., 2019, Text book for UV-Vis Spectroscopy, Mahi publication India.
2. Dr. Sawant Ramesh. Joshi Rupali.2016. Handbook of experimental ultraviolet absorption spectroscopy. Career Publications
3. De Caro, Cosimo & Claudia, Haller. (2015). UV/VIS Spectrophotometry - Fundamentals and Applications. Mettler Toledo Ag

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B. Sc. I Semester II
Practical Paper I: UV-Vis Spectroscopy Techniques

Course Objective:

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

Sr. No.	List of Experiments	Credits 1
1.	Measurement of transmittance	2
2.	Measurement of absorbance	2
3.	Calculation of bandgap using absorbance curve	2
4.	Interpretation of UV-vis spectrophotometer	2
5.	Use of UV-vis spectrophotometer in pharma	2
6.	Sample preparation for UV-vis spectrophotometer	2

Course Outcomes:

After completion of this course students will able to

1. To understand theoretical knowledge Ultraviolet visible spectrophotometer.
2. Understand the transmittance and absorbance.
3. Calculate bandgap using absorbance curve

Reference Books:

1. Birasdar R. S., 2019, Text book for UV-Vis Spectroscopy, Mahi publication India.
2. Dr. Sawant Ramesh. Joshi Rupali.2016. Handbook of experimental ultraviolet absorption spectroscopy. Career Publications
3. De Caro, Cosimo & Claudia, Haller. (2015). UV/VIS Spectrophotometry - Fundamentals and Applications. Mettler Toledo Ag

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Value Education Course (VEC)

B.Sc. I Semester II

VEC104: Understanding India (Credits: 02)

1) TITLE	**:**	Understanding India
2) YEAR OF IMPLEMENTATION	**:**	2023-2024
3) CLASS	**:**	B.Sc. I
4) DURATION	**:**	Semester II
5) MEDIUM OF INSTRUCTION	**:**	English/Marathi

Course Objectives: Students should be able to …..

1. Understand India's geographical, social, and economic scenario.
2. Comprehend the Cultural heritage and literary traditions of India.
3. Familiarize with the phases of making of contemporary India.

Units	VEC104: Understanding India	No. of Hours (Credit-02)
Unit I	**Introducing India-** • The Land of India: landscape, mountains and rivers , • The People of India: demography , • religion and languages , • The Name of our Country: Jambudvipa, • Sindhu (Indus), Inde, Hind, Hindustan, Bharat, India.	06
Unit II	• Architecture and Sculpture: Indus Valley town planning, rock cut architecture, major styles of temples, Mughal architecture, modern and contemporary architecture, stone and metal sculpture • Painting: Ajanta murals, Mughal paintings, Madhubani paintings, paintings of Jharkhand (Kohbar, Sohrai, Jadopatia, etc.). • Music, Theatre and Dance: Overview of various forms of music and dances in India, • Science, Technology and Medicine: A general survey of the progress of science, Technology, and Medicine in ancient India	08
Unit III	**Understanding Literary Traditions** • Panini, Kalidasa, Veda Vyasa, Valmiki • Regional literary traditions, Bhakti Poetry, Folk literature	08

Unit IV	• Making of contemporary India • Political and Social Movements in Pre and Post Independent India	08

Course Outcomes: After completion of the course, students will be able to:

- Explain the Unity in diversity in India.
- Evaluate the cultural heritage of India.
- Describe the literary traditions of India.
- Apply the theories and practices concerning the movements in making of contemporary India.

Reference Books:

1. Basham A. L., 1997, A Cultural History of India, Oxford University Press.
2. Lahiri N., 2012, Marshaling the Past: Ancient India and its Modern Histories, Permanent Black.
3. Ray Tirthankar, 2006 The Economic History of India 1857-1947, OUP.
4. Braj, B. Kachru, et.al., 2013, Languages in South Asia, Cambridge University Press.
5. Herman Kulke and Deitmar Rothermund, 2016. A History of India, Taylor and Francis.
6. Krishna Chaitanya, 1976, A Profile of Indian Culture, The Indian Book Company, New Delhi.
7. N.R. Ray, 1974, An Approach to Indian Art, Publication Bureau, Chandigarh.
8. R.S. Sharma, 2020, India's Ancient Past, Oxford University Press.

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