Rayat Shikshan Sanstha's

Yashavantrao Chavan Institute of Science, Satara (Autonomous)

Lead College Karmaveer Bhaurao Patil University, Satara

Re Accredited by NAAC (3rdCycle) with 'A+' grade (CGPA 3.57).

ISO 9001:2015 Certified

Bachelor of Science

Part - I

NANOSCIENCE AND TECHNOLOGY (ENTIRE)

Syllabus

to be implemented w .e. f. June, 2024

NEP 2020

B. Sc. Part I

1) **Title:** Nanoscience and Technology (Entire)
2) **Year of Implementation:** The syllabus will be implemented from June, 2024
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. Explain 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:**

SEMESTER I

Sr. No.	Course	Name of the course	Name of the Paper	Credits
1	Course 1	DSC -I	**BNTT 111:** Introduction to Nanoscience and Nanotechnology	2
		DSC -II	**BNTT 112:** Properties of Nanomaterials	2
		DSC **(P)** -I	**BNTP 113:** Practical: Based on DSC –I and DSC -II	2
2	Course 2	DSC -I	**BNTT 114:** Physics for Nanoscience I	2
		DSC -II	**BNTT 115:** Digital Electronics	2
		DSC **(P)** -I	**BNTP 116:** Practical : Based on DSC –I and DSC -II	2
3	Course 3	DSC -I	**BNTT 117:** Chemistry for Nanoscience I	2
		DSC -II	**BNTT 118:** Chemistry for Nanoscience II	2
		DSC **(P)** -I	**BNTT 119:** Practical : Based on DSC –I and DSC -II	2
4	Open Elective	OE-1	**BNTT-OE 1:** Astronomical Studies	2
5	IKS-I	Generic	**BNTT IKS 1:**(Generic)	2
			Total	**22**

SEMESTER II

Sr. No.	Course	Name of the course	Name of the Paper	Credits
1	Course 1	DSC –III	**BNTT 121:**Synthesis of Nanomaterials I	2
		DSC –IV	**BNTT 122:**Synthesis of Nanomaterials II	2
		DSC **(P)** -II	**BNTT 123:**Practical II: Based on DSC –III and DSC -IV	2
2	Course 2	DSC –III	**BNTT 124:**Physics for Nanoscience II	2
		DSC –IV	**BNTT 125:**Semiconductor Devices	2
		DSC **(P)** -II	**BNTT 126:**Practical II: Based on DSC –III and DSC -IV	2
3	Course 3	DSC –III	**BNTT 127:**Nanobiology I	2
		DSC –IV	**BNTT 128:**Nanobiology II	2
		DSC **(P)** -II	**BNTT 129:**Practical II: Based on DSC –III and DSC -IV	2
4	Open Elective	OE - 2	**BNTT OE 2:**Astronomical Studies	2
5	VEC – I	DEIC	**BNTT VEC 1:**Democracy, Election and Indian Constitution	2
			Total	**22**

B. Sc. I Semester-I

BNTT 111: Introduction to Nanoscience and Nanotechnology

Course Objectives: The students should be able to…

1. Gain interest towards nanoscience & nanoscale materials.
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. Explain 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: The 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. Explain 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 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 (Credit-02)	No. of Hours 60
1.	To Identify the Nano Effects in the Nature.	04
2.	To study the Classification of Nanomaterials.	04
3.	Introduction to lab equipment I: Weighing balance, pH & Conductivity meter, Colorimeter, Potentiometer, Centrifuge, Hot Air Oven, Autoclave, Muffle Furnace, Distillation unit, Sonicator.	04
4.	Introduction to lab equipment II: a) Measurement of pH and Conductivity. b) Use of Colorimeter and Potentiometer.	04
5.	Measurement of Surface to Volume Ratio.	04
6.	Young's Modulus of Material of Bar by Vibration.	04
7.	Poisson's Ratio for Rubber using Rubber Tube.	04
8.	Measurement of Transmittance and Absorbance of Nanomaterials.	04
9.	Diffraction due to Single slit using Sodium / Laser Source.	04
10.	To Investigate the Relationship between the Angle of Incidence	04

	(i) and the Angle of Refraction (r)	
11.	To Determine the Refractive Index of a Transparent Solid Medium e.g. Glass.	04
12.	To study the Characteristics of the Forward and Reverse Biased Junction Diode.	04
13.	To Determine the Energy Band Gap of a Semiconductor by using PN Junction Diode.	04
14.	Determination of thermal conductivity of a Bad Conductor. (Lee's disc)	04
15.	To study Faradays Magnetic Field Induction.	04

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. Explain 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: Digital Electronics

Course Objective: Students should be able to …

1. Learn different number systems and digital conversions
2. Understand the working of logic gates and there use in logic operations
3. Apply the knowledge of data processing circuits in digital circuit design.
4. Understand the working of sequential logic circuits.

Units	BNTT 115: Digital Electronics	No. of Hours 30 (Credit: 2)
Unit I	**Number System and Codes:** Decimal, Binary, Octal and Hexadecimal number systems, base conversions. Representation of signed and unsigned numbers, BCD code. Binary, octal and hexadecimal arithmetic; addition, subtraction by 2's complement method, multiplication	06

Unit II	**Logic Gates and Boolean Algebra :** Truth Tables of OR, AND, NOT, NOR, NAND, XOR, XNOR, Universal Gates, Basic postulates and fundamental theorems of Boolean algebra. **Combinational Logic Analysis and Design:** Standard representation of logic functions (SOP and POS), Minimization Techniques (Karnaugh map minimization up to 4 variables for SOP).	06
Unit III	**Arithmetic Circuits:** Binary Addition. Half and Full Adder. Half and Full Subtractor, 4- bit binary Adder / Subtractor. **Data processing circuits:** Multiplexers, De-multiplexers, Decoders, Encoders.	08
Unit IV	**Sequential Circuits:** SR, D, and JK Flip-Flops. Clocked (Level and Edge Triggered) Flip-Flops. Preset and Clear operations. Race-around conditions in JK Flip-Flop. Master-slave JK Flip-Flop. **Shift registers:** Serial-in-Serial-out, Serial-in-Parallel-out, Parallel-in-Serial-out and Parallel-inParallel-out Shift Registers (only up to 4 bits). **Counters (4 bits):** Ring Counter. Asynchronous counters, Decade Counter, Synchronous Counter	10

Course Outcomes: Students will be able to…

1. Perform the conversions of numbers from one number system to another.
2. Explain concepts of logic gates and there working
3. Design Arithmetic and logic circuits.
4. Analyze and design sequential logic circuits.

Reference Books-

1. P. Malvino, D. P. Leach and Saha, 2011, Digital Principles and Applications, 7th Ed.,Tata McGraw
2. R. L. Tokheim, (1994)Digital Principles, Schaum's Outline Series, Tata McGraw-Hill
3. S.K. Mandal, 2010, Digital Electronics, 1st edition, McGraw Hill
4. Anand Kumar, 2009, Fundamentals of Digital Circuits, PHILearning Pvt.Ltd. 2nd Edn.
5. Thomas L. Flyod, (1994), Digital Fundamentals, Pearson Education Asia

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B. Sc. I Semester: I
BNTP 116: Practical Lab II

Course Objectives: Students should be able to…

1. Demostrate the basic principles and effects in physical sciences.
2. Explain Scherer's formula for determining lattice constant and crystalline size.
3. Understand the working of basic logic gates.
4. Design and analyze basic logic circuits.

Sr. No.	Title of the experiments (Credit-02)	No. of Hours 60
1.	To determine Youngs modulus (Y) of a wooden bar.	04
2.	To determine the contact angle.	04
3.	Viscosity by Poiseuille's method.	04
4.	Determination of the surface tension of a liquid by Jaeger's method.	04
5.	Determine the surface tension of a given liquid at room temp using stalgomometer by drop number method	04
6.	Determination of the lattice constant by using Scherrer formula.	04
7.	Determination of crystalline size using Scherer's formula	04
8.	Study of basic logic gate	04
9.	Study universality of NAND and NOR gate	04
10.	a) To design a combinational logic system for a specified Truth Table. b) To convert Boolean expression into logic circuit & design it using logic gate ICs.	04
11.	Half Adder and Full Adder.	04
12.	Half Subtractor and Full Subtractor	04
13.	To build Flip-Flop (RS, Clocked RS, D-type and JK) circuits using NAND gates.	04
14.	To build JK Master-slave flip-flop using Flip-Flop ICs	04
15.	To build a Counter using D-type/JK Flip-Flop ICs and study timing diagram.	04

Course Outcomes: Students will be able to…

1. Evaluate surface tension by different methods.
2. Analyze contact angle.
3. Apply Scherrer formula for determination of crystalline size and lattice constant.
4. Design and analyze various types of logic circuits.

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. P. Malvino, D. P. Leach and Saha, 2011, Digital Principles and Applications, 7th Ed.,Tata McGraw
4. Thomas L. Flyod, (1994), Digital Fundamentals, Pearson Education Asia

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B. Sc. I Semester I

BNTT 117: 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 117: 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 Lowry 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: II
BNTT 118: Chemistry for Nanoscience II

Course Objectives: Students should 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 118: Chemistry for Nanoscience II	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: I

BNTP 119: Practical Lab III

Course Objectives: Students should be able to…

1. Learn the basic principles and effects in chemical sciences.
2. Describe and understand the instrumental and non – instrumental experiments.
3. Evaluate chemical oxygen demand in waste water.
4. Analyze quantitative analysis of organic compound.

Sr. No.	Title of the experiments (Credit-02)	No. of Hours/ 60
1.	Preparation of Standard Solution	04
2.	To determine the heat of ionization of a weak acid by using polythene bottle.	04
3.	To investigate the reaction between potassium per sulphate and potassium iodide withequal initial concentration of reactants.	04
4.	To determine equivalent weight of metal (mg) by hydrogen displacement method usingEudiometer	04
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	04
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	04
7.	Determination of enthalpy of neutralization of hydrochloric acid with sodium hydroxide	04
8.	Determination of total hardness of water.	04
9.	Determination of chemical oxygen demand (COD) of industrial wastewater sample	04
10.	Quantitative analysis of organic compound	04
11.	Preparation mechanism of various reactions involved to be discussed recrystallization.	04
12.	Determination of melting point and calculation of quantitative yieldto be done	04
13.	To Study of molarity of benzoic acid in water.	04
14.	To determine melting point of given solid sample.	04
15.	To determine boiling point of given liquid sample.	04

Course Outcomes: Students will be able to…

1. Use sophisticated equipment used in laboratory.
2. Perform experiments to know the basics of physico- chemical properties of elements.
3. Analyze the industrial practices.

Reference Books-

1. Hannaford B. S. Smith A. J. Tatchell P.W. 2012. Practical Organic Chemistry. 5th Edition.
2. Lechtanski Valerie Ludwig. 2000. Inquiry-based Experiments in Chemistry. Oxford University.

Syllabus for Open Elective Course
Course Name: Astronomical Studies
B. Sc. I Semester: I
BNTT OE 1: Astronomy for Beginners

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B. Sc. I (Nanoscience and Technology) Semester I
BNTT IKS 1 (Generic)

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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 PublishingCompany.
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 Chemical Vapor Deposition 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 Lab IV

Course Objectives: The student should be able to…

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

Sr. No.	Title of the Experiments (Credit-02)	No. of Hours 60
1.	Techniques of Glass/FTO/ITO/Aluminum substrate cleaning.	04
2.	Synthesis of CdS Nanoparticles by Co-precipitation method.	04
3.	Synthesis Nikel Oxide thin film preparation by SILAR method.	04
4.	Synthesis of Zinc oxide nanoparticles by Chemical Reduction method.	04
5.	Synthesis of Nikel nanoparticle by Electrodeposition method.	04
6.	Synthesis of Copper nanoparticle by using plant extraction.	04
7.	CdS thin film deposition by CBD method.	04
8.	Biological synthesis of Iron oxide nanoparticles.	04
9.	To Synthesis of MgO thin film by SILAR Technique.	04
10.	Synthesis of NiO nanoparticle by Hydrothermal method.	04
11.	Synthesis of CdS nanoparticle by Fungi.	04
12.	Synthesis of Pt nanoparticle by bacteria.	04
13.	Biosynthesis of silver nanoparticles using plant leaves extract.	04
14.	Synthesis of Zinc oxide thin film by spray pyrolysis technique	04
15.	Synthesis of Ferrite (Fe2O3)nanomaterial by Solvothermal technique	04

Course Outcomes: Students will be able to…

1. Discuss the physical, chemical and biological approach of nanomaterial synthesis.
2. Design nanoparticles by using various methods.
3. Prepare thin films of various materials by using chemical route.
4. Handle 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. Explain 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: Semiconductor Devices

Course Objectives: Students should be able to…

1. Learn the semiconductor properties of materials.
2. Explain the concept of PN junction.
3. Analyze the working of semiconductor devices.
4. Understand the working principle of Opto-electronic devices.

Units	BNTT 125: Semiconductor Devices	No. of Hours 30 (Credit: 2)
Unit I	**Semiconductor Basics**: Conductor, Semiconductor, Insulator, Introduction to Semiconductor Materials, Carrier Transport Phenomena: Carrier Drift, Mobility, Resistivity, Hall Effect, Diffusion Process, Einstein Relation, Current Density Equation, Carrier Injection, Generation and Recombination Processes, Continuity Equation.	06
Unit II	**P-N Junction Diode:** Formation of Depletion Layer, Space Charge, Electrostatic Potential Difference at Thermal Equilibrium, Depletion Width and Depletion Capacitance of an Abrupt Junction, Concept of Linearly Graded Junction, Derivation of Diode Equation and I-V Characteristics, Idea of Static and Dynamic Resistance, Q point and DC Load Line.	08
Unit III	**Applications of PN Junction:** Zener and Avalanche Breakdown Mechanism, Zener diode as voltage regulator, photodiode Schottky diode, Tunnel diode, point contact diode. **JFET:** Construction, working and I-V characteristics (output and transfer), Pinch-off voltage. **UJT:** basic construction, working, equivalent circuit and I-V characteristics.	08
Unit IV	**Optoelectronic Devices:** Light- emitting diodes and lasers: Photon absorption and emission, Inter-band emission and absorption in semiconductors, Laser diodes, Light- emitting diodes.	08

Course Outcome: Students will be able to…

1. Explain Basic concepts and phenomenon in semiconductor materials.
2. Demonstrate and analyze the construction and working of PN junction diode.
3. Applications of PN junction in semiconductor devices
4. Explain the construction and working of Semiconductor devices.

Reference Books:

1. R. S. Sedha, Textbook of Applied Electronics, S. Chand Publication
2. Ben G Streetman and S. Banerjee, (2006), Solid State Electronic Devices, Pearson Education
3. Jasprit Singh, (2001) Semiconductor Devices: Basic Principles, John Wiley and Sons
4. Robert F. Pierret, (2006) Semiconductor Device Fundamentals, Pearson Education.

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B. Sc. I Semester: II
BNTP 126: Practical Lab V

Course Objectives: Students should be able to…

1. Demonstrate and understand Wave nature.
2. Learn the Sci Lab Software.
3. Perform measurement of electronic parameters.
4. Analyze characteristics of semiconductor devices.

Sr. No.	Title of the experiments (Credits: 2)	No. of Hours 60
1.	Huygens's principle in water waves.	04
2.	To determine the wavelength of a given monochromatic light by investigating thediffraction pattern by a straight edge.	04
3.	To study the photoelectric effect, variations of photocurrent versus intensity andwavelength of light.	04
4.	Sci lab Experiment I (Problem from quantum mechanics)	04
5.	Sci Lab Experiment II (Problem from quantum mechanics)	04
6.	Diffraction due to single slit using sodium/ Laser source.	04
7.	Calibration of spectrophotometer	04
8.	Measurement of wavelength of LASER using plane diffraction grating	04
9.	To familiarize with basic electronic components (R, C, L, diodes, transistors) digital Multimeter, Function Generator and Oscilloscope	04
10.	Study of the I-V Characteristics of p-n junction Diode	04
11.	Study of the I-V Characteristics of Zener diode	04
12.	Study of the I-V Characteristics UJT	04
13.	Study of the output and transfer I-V characteristics of common source JFET	04
14.	Study of I-V characteristics Solar cell	04
15.	Characteristics of Photodiode	04

Course Outcomes: Students will be able to…

1. Demonstrate and understand Wave nature.
2. Perform mathematical analysis using Sci Lab Software
3. Understand working of various semiconductor devices.
4. Analyze the characteristics of semiconductor devices.

Reference Books-

1. Panigrahi S. Mallick B. 2015. Engineering practical physics. Cengage learning India Pvt. Ltd.
2. Indu Prakash and Ramkrishna, Kitaab Mahal, 2011. A textbook of practical physics. 11th edition.
3. Ben G Streetman and S. Banerjee, (2006), Solid State Electronic Devices, Pearson Education
4. Jasprit Singh, (2001) Semiconductor Devices: Basic Principles, John Wiley and Sons

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B. Sc. I Semester II
BNTT 127: Nano-biology I

Course Objectives: Students should be able to…

1. Define basics of chemical science in relevance to biological systems
2. Know concept of evolution
3. Understand fundamental Biomolecules
4. Memorize biomolecules

Units	BNTT 127: Nano-biology I	No. of Hours 30 (Credit: 2)
Unit I	**Origin of life** Basic concept, A.I. Oparin concept, Urey Miller's experiment, Concept of Biomolecules-in general about Carbohydrate, amino acids, protein, lipid just definition with at least one example. pH, pk value definition, Biological buffer systems-e.g. Phosphate, Bicarbonate, Hemoglobin buffer system.	06
Unit II	**Nucleic Acids** Structure and functions of Nucleic acids, purines& pyrimidines, Nucleosides & Nucleotides, Biologically important nucleotides, Double helical model of DNA structure and forces responsible for A, B & Z – DNA, denaturation and denaturation of DNA, RNA and its Types (rRNA, tRNA, mRNA).	08
Unit III	**Carbohydrates** Structure, Function, Classification, Characteristic Reactions, Physical and Chemical Properties, D&L Glyceraldehydes, structure of Monosaccharide, Disaccharides, and Polysaccharides. Chemical/Physical Properties of Carbohydrate, Chemical Reactions for Detection of Monosaccharides, Biological functions of carbohydrates	08
Unit IV	**Lipids** Classification of Lipids, Properties of Saturated, Unsaturated Fatty Acids, Rancidity, and Hydrogenation of Oils Phospholipids: Lecithin, Cephalin structure and function Cholesterol: Structure and Function, Lipoproteins: Structure and Function, Storage Lipids, Structural Lipids	08

Course Outcome: Students will be able to…

1. Illustrate basics of chemical science in relevance to biological systems
2. Describe the concept of evolution
3. Discuss the biomolecules
4. Classify the biomolecules

Reference Books:

1. Voet J. G., Voet D., Pratt C.W., 5th Ed. Fundamentals of Biochemistry, John Wiley and Sons Inc, New York, USA, 2016
2. Satyanarayanan U. 4th edition Biochemistry Elsevier, 2016
3. Com E.E & Stumpf P.K. 5th Ed. John .Outlines of Biochemistry. Wiley Publications, 2010
4. Palmer T., Philip B. 2nd Edition, Enzymes: Biochemistry, Biotechnology, and clinical Chemistry, , Woodhead Publishing, 2007

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B. Sc. I Semester II
BNTT 128: Nano-biology II

Course Objectives: Students should be able to…

1. Inspire and boost the interest of the students towards Basic of Biology.
2. Learn and understand functions of biomolecules.
3. Adopt knowledge about energy metabolism process.
4. Study the immunology

Units	BNTT 128: Nano-biology II	No. of Hours 30 (Credit: 2)
Unit I	**Basics of Biology I** Structure and function of cells and organelles in Prokaryotes and Eukaryotes. – Nucleus, chromosome organization, structure and function of genetic material, Ribosomes	06
Unit II	**Basics of Biology II** Introduction and structure of Endoplasmic reticulum, Golgi apparatus, Mitochondria, Lysosome and the Plasma membrane. Cell division and Cell Cycle - Mitosis - Meiosis	08
Unit III	**Energy Metabolism** Energy Metabolism - aerobic respiration and anaerobic respiration - Glycolysis (EMP Pathway), Tricarboxylic acid cycle (TCA), Electron Transport Chain, Substrate level phosphorylation and oxidative phosphorylation - ATP generation, Gluconeogenesis.	08
Unit IV	**Immunology** History of immunology, Innate and acquired immunity, Hematopoiesis, Cells and organs of the immune system. B and T- cell activation. Phagocytosis – Oxygen dependent and Oxygen independent killing. Antigen -Properties of antigen. Antibody- structure and types. Hybridoma Technology. Immuno-hematology, Blood group, Rh - incompatibilities. Immuno techniques – ELISA, RIA	08

Course Outcome: Students will be able to…

1. Explain basic structure of cells and organs
2. Analyze the structure of DNA and RAN
3. Explain energy metabolism processes
4. Explain antibody structure and its types

Reference Books:

1. Campbell, Neil A., and Jane B. Reece. Biology. 10th ed. San Francisco: Pearson Eduction, 2019.
2. Lander, Geoffrey M., and Robert E. Hausman. The Cell: A Molecular Approach. 8th ed. Sunderland, MA: Sinauer Associates, 2019
3. Lewin, Benjamin. Genes X. 10th ed. Burlington, MA: Jones & Bartlett Learning, 2018
4. Lanza R., Atala A., 3rd Edition Essentials of stem cell biology, , Academic press, 2013

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B. Sc. I Semester: II

BNTP 129: Practical Lab VI

Course Objectives: Students should be able to…

1. Understand concepts of solutions and buffers
2. Know about various biomolecules
3. Understand biomolecules detection techniques
4. Know different Research organizations in India

Sr. No.	Title of the experiments (Credits: 2)	No. of Hours 60
1.	To determine sugars by Molisch test, Benedict's test & Barfoed's test	04
2.	To determine sugars by Fehling's test	04
3.	To perform Qualitative tests for Non - Reducing Sugars	04
4.	To Detect of unknown Carbohydrate from mixture (Glucose, fructose, maltose, sucrose, xylose and starch)	04
5.	To estimate Glucose by DNSA method	04
6.	To Determine iodine number of oil sample	04
7.	To Estimation of vitamin C (Ascorbic acid)	04
8.	Finding the coagulation time of blood	04
9.	Latex Agglutination	04
10.	Sterilization procedure for glassware, media and plastic ware	04
11.	Preparation of buffers (Phosphate buffer, acetate buffer) and determination of pH with pH meter	04
12.	Preparation of culture media for bacteria (Using pepton water, Nutrient broth, Nutrient agar, Mc Conkey's agar)	04
13.	Pure culture Techniques (i) Spread Plate (ii) Pour Plate (iii) Streak Plate	04
14.	Morphology of (i) Bacteria – Gram Staining and (ii) Fungi - Lacto Phenol Cotton Blue Mount	04
15.	To study mitosis using onion root tips	04

Course Outcomes: Students will be able to…

1. Apply knowledge in working of various instruments related to biotechnology
2. Analyse various biomolecules & their qualitative analysis
3. Prepare Buffer, Standardized and calibrate pH meter.
4. Understand sterilization process.

Reference Books-

1. Upadhyay A. , Upadhyay K., Nath N., 4th Edition Biophysical Chemistry Himalaya Publishing House Pvt. Ltd., 2016
2. Wilson K. and Walker J., 8th edition Principles and Techniques of Biochemistry and Molecular Biology Cambridge University Press; 2018
3. Plummer D., 3rd Edition An Introduction to Practical Biochemistry McGraw Hill Education; 2017
4. Champe P. C., Harvey R. A., Ferrier D. R. 3rd edition. Biochemistry Lippincott Williams and Wilkins; 2004
5. Sadasivam S, Manickam 2nd edition A Biochemical methods., New Age International (p) Ltd. Publisher, New Delhi., 1996
6. Plummer D. 3rd ed An Introduction to Practical Biochemistry.. Tata McGraw Hill, New Delhi, 1988

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Syllabus for Open Elective Course
Course Name: Astronomical Studies
B. Sc. I Semester: II
BNTT OE 2: Stellar Objects

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B. Sc. I (Nanoscience and Technology) Semester I
BNTT VEC 1 DEGG AND IIC

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Evaluation Structure for B. Sc. I 2024-25

Theory: UG

Assessment Category	Internal Evaluation				ESE	Total Marks	Credits
	CCE-I	CCE-II	Mid Sem	Total			
Theory Paper of 2 Credits	5	5	10	20	30	50	02

Note: 1) For IKS, CC & VEC - Evaluation Structure will be informed separately

Practical: UG

Assessment Category	Internal Evaluation	ESE	Total Marks	Credits
	Journal / Viva / Activity			
Practical Paper of 2 Credits	20	30	50	02