



**Rayat Shikshan Sanstha's**

**Yashwantrao Chavan Institute of Science,  
Satara**

**(Autonomous)**

**(Lead College, Karmaveer Bhaurao Patil University, Satara)**

**Department of Chemistry**

**B. Sc. II Syllabus**

**(As per NEP 2020)**

**w.e.f. June 2024**



**1. Title:** B. Sc. Chemistry

**2. Year of Implementation:** 2024-2025

**3. Preamble:** This updated syllabus is prepared for Second year undergraduate students. At this level, to develop their interest towards chemistry as basic science and also to prepare them for the academic and industrial exposure simultaneously. Introduction of instrumental techniques with the regular chemistry exercises will help to enhance analytical thinking of the students. The interdisciplinary approach with vigor and depth is compatible to the syllabi of other universities, at the same time is not rigid for the students at second year of their graduation. The units in the syllabus are well defined with scope and the number of lectures. The references are mentioned with relevance.

**4. General Objectives of the Course:**

1. To develop the content of the syllabus according to the UGC norms.
2. To inculcate fundamental principles of chemical sciences in students.
3. To establish the link between theory and laboratory practice by conducting laboratory experiments which help students to improve the understanding of the concepts.
4. To enhance student's sense of enthusiasm for chemistry and to involve them in an intellectually stimulating experience of learning in a supportive environment.

**5. Duration:** One year

**6. Pattern:** Semester

**7. Medium of Instruction:** English

**8. Structure of Course:**

Level	Sem	Subject -1 Major				Subject -2		Subject -3		VSEC					Total
		DSC		DSE		Minor		GE/OE		VSC	SEC	AEC	VEC	CC	
		T	P	T	P	T	P	T	P						
5	III	4	4	-	-	2	2			2	2	4	2	-	22
	IV	4	4	-	-	2	2			2	2	4		2	22

Subject	Sem	Name of Major Papers	Name of Minor Papers	Value Education Course (VEC)	Co-curricular (CC)	Skill Enhancement Course (SEC)	Vocational Skill Course (VSC)
Chemistry (Level 5)	III	1) BCT 231: Organic Chemistry	BCT 235: Applied Chemistry-I	BCTVEC II: Environmental Awareness for Chemistry		BCPSEC-II Water Quality Analyst	BCPVSC-I Food Quality Analyst
		2) BCT : 232 Analytical Chemistry					
		BCP 233 BCP 234	BCP 236				
	IV	3) BCT : 241 Physical Chemistry	BCT 245: Applied Chemistry-II Chemistry		BCTCC-II Village Services Through Volunteers	BCPSEC-III Soil Quality Analyst	BCPVSC-II Fertilizer Technologist
		4) BCT : 242 Inorganic Chemistry					
		BCP 243 BCP 244	BCP 246				

## Structure and Titles of Major Course

Semester	Theory Course (Major) Credits 4		Practical Course (Semester Wise) Credits 2	Practical Course (Semester Wise) Credits 2
III	Course Code: BCT-231 Course I- Organic Chemistry	Course Code: BCT-232 Course II- Analytical Chemistry	Course Code: BCP: 233 Major Practical III	Course Code: BCP: 234 Major Practical IV
IV	Course Code: BCT-241 Course III- Physical Chemistry	Course Code: BCT-242 Course IV- Inorganic Chemistry	Course Code: BCP : 243 Major Practical V	Course Code: BCP : 244 Major Practical VI

### Semester III

#### Course I : Organic Chemistry (BCT 231)

Subject	Unit No.	Title	Hrs.	Credits
Organic Chemistry	I	Organic Name reactions and Reagents	08	2
	II	Amines and Diazonium Salts	08	
	III	Carbohydrates	08	
	IV	Amino acids, Proteins, Nucleic Acids	06	
Grand Total			30	

#### Course II: Analytical Chemistry (BCT 232)

Subject	Unit No.	Title	Hrs.	Credits
Analytical Chemistry	I	Optical Methods of Analysis	08	2
	II	Electroanalytical Methods of Analysis	08	
	III	Qualitative Analysis	07	
	IV	Quantitative Analysis	07	
Grand Total			30	

### Semester IV

#### Course III: Physical Chemistry (BCT 241)

Subject	Unit No.	Title	Hrs.	Credits
Physical Chemistry	I	Electrochemistry Part I- Electrolytic Conductance and Transference	08	2
	II	Electrochemistry Part II- Electromotive Force	08	
	III	Physical Properties of Liquids	07	
	IV	Chemical Kinetics	07	
Grand Total			30	

#### Course IV: Inorganic Chemistry (BCT 242)

Subject	Unit No.	Title	Hrs.	Credits
Inorganic Chemistry	I	Elements of First Transition Series	08	2
	II	Lanthanide and Actinides	08	
	III	Co-ordination Chemistry	07	
	IV	Chelation	07	
Grand Total			30	

<b>B. Sc. Part II, Semester III</b>		
<b>Credits 2</b>	<b>Course I: Organic Chemistry Course Code: BCT – 231</b>	<b>No. of Hrs. 30</b>
	<p><b>Course Objectives: Students should be able to...</b></p> <ol style="list-style-type: none"> <li>1. Understand the fundamental principles underlying organic reaction mechanism.</li> <li>2. Study the preparation and reactions of amines and diazonium salt.</li> <li>3. Learn the classification, structures and reactions of carbohydrates.</li> <li>4. Examine the structure and properties of amino acids, including chirality and acid-base behaviour.</li> </ol>	
<b>Unit No.</b>	<b>Title and Syllabus</b>	<b>Hrs. Allotted</b>
<b>I</b>	<p><b>Organic Name Reactions:</b></p> <ol style="list-style-type: none"> <li>1.1 Perkin reaction</li> <li>1.2 Reformatsky Reaction</li> <li>1.3 Knoevenagel Condensation</li> <li>1.4 Claisen condensation</li> <li>1.5 Mannich Reaction</li> <li>1.6 Pinacole – Pinacolone Reaction</li> <li>1.7 Clemmenson Reduction</li> <li>1.8 Reimer – Tiemann reaction.</li> </ol>	<b>8</b>
<b>II</b>	<p><b>Amine and Diazonium Salt:</b></p> <ol style="list-style-type: none"> <li>2.1 Amines (Aliphatic and Aromatic): (Upto 5 carbons) Preparation: from alkyl halides, Gabriel's Phthalimide synthesis, and Hofmann Bromamide reaction.</li> <li>2.2 Reactions: Hofmann vs. Saytzeff elimination, Carbylamines test, Heinsberg test, Reaction with HNO<sub>2</sub>, Schotten – Baumann Reaction. Electrophilic substitution (case aniline): nitration, bromination, sulphonation.</li> <li>2.3 Diazonium salts: Preparation: from aromatic amines. Reaction: conversion to benzene, phenol, dyes.</li> </ol>	<b>8</b>
<b>III</b>	<p><b>Carbohydrates:</b></p> <ol style="list-style-type: none"> <li>3.1 Classification based on chemical constitution with suitable example- Sources open chain and ring structure of carbohydrate containing five and six carbon atom,</li> <li>3.2 Interconversion of glucose and fructose</li> <li>3.3 Determination of configuration of glucose, Muta-rotation,</li> <li>3.4 Reactions of glucose, acetylation, Osazone, methylation, reduction and oxidation</li> <li>3.5 Chain lengthening and shortening reaction.</li> </ol>	<b>8</b>
<b>IV</b>	<p><b>Amino acids, Proteins and Nucleic acids:</b></p> <ol style="list-style-type: none"> <li>4.1 General structure of amino acid, isoelectric point,</li> <li>4.2 Synthesis of an amino acid- amination of halo acid, aza-lactone, Curtius method, Gabriel method.</li> <li>4.3 Synthesis of polypeptide Solid phase synthesis, structure of protein,</li> <li>4.4 Nucleic acid – classification, structure of nucleosides &amp; nucleotides</li> </ol>	<b>6</b>

	<p><b>Course Outcomes: After completion of the course students will be able to...</b></p> <ol style="list-style-type: none"><li>2. Draw the mechanism of various name reactions.</li><li>3. Explain the synthetic methods and applications of amines and diazonium salts.</li><li>4. Classify the various carbohydrates.</li><li>5. Explore the structures of amino acids, proteins and nucleic acids and their synthetic methods.</li></ol>	
	<p><b>References:</b></p> <ol style="list-style-type: none"><li>1. Madan R. L. 2016. Chemistry for Degree students: S. Chand.</li><li>2. Morrison &amp; Boyd 2002. Organic Chemistry: Pearson Education, Prentice Hall of India, 6<sup>th</sup> Edition.</li><li>3. Ahluwalia V. K., Parashar R. K. 2010. Organic Reaction Mechanism: Narosa Publishing House, 4<sup>th</sup> Edition.</li><li>4. Jerry March 1992. Advanced Organic Chemistry: Reactions, Mechanism and Structure: Wiley, 4<sup>th</sup> Edition.</li></ol>	

Credits 2	Course II: Analytical Chemistry Course Code: BCT – 232	No. of Hrs. 30
	<p><b>Course Objectives: Students should be able to...</b></p> <ol style="list-style-type: none"> <li>1. Learn basic principles of spectroscopy.</li> <li>2. Absorb the knowledge of electroanalytical methods of analysis.</li> <li>3. Acquire the fundamental knowledge of qualitative analysis.</li> <li>4. Understand the methods of quantitative analysis.</li> </ol>	
Unit No.	Title and Syllabus	Hrs. Allotted
I	<p><b>Optical Methods of Analysis:</b></p> <ol style="list-style-type: none"> <li>1.1 Origin of spectra, interaction of radiation with matter.</li> <li>1.2 Fundamental laws of spectroscopy and selection rules, validity of Beer – Lambert’s law.</li> <li>1.3 UV – Visible Spectrometry: Basic principles, instrumentation (choice of source, monochromator and detector) for single and double beam instrument.</li> <li>1.4 Infrared Spectrometry: Basic principles of instrumentation (choice of source, monochromator &amp; detector) for single and double beam instrument; sampling techniques.</li> </ol>	8
II	<p><b>Electro Analytical Methods:</b></p> <ol style="list-style-type: none"> <li>2.1 Classification of electro analytical methods, Basic principle of i] pH meter ii] Potentiometer and iii] Conductometer.</li> <li>2.2 Conductance measurement- Direct reading conductivity bridge, conductivity cell and cell constant</li> <li>2.3 Conductometric Titrations: Introduction, Instrumentation</li> <li>2.4 Types of conductometric Titrations, Advantages and disadvantages of conductometric Titrations.</li> </ol>	8
III	<p><b>Qualitative Analysis:</b></p> <ol style="list-style-type: none"> <li>3.1 Qualitative Analysis-Principle of qualitative analysis</li> <li>3.2 Classification of organic and inorganic qualitative analysis</li> <li>3.3 Organic Qualitative Analysis-Identification of compounds, the functional group analysis</li> <li>3.4 Inorganic Qualitative Analysis-Application of solubility product and common ion effect, separation of cation into groups, Application of complex formation, Application of oxidation–reduction in inorganic qualitative analysis</li> <li>3.5 Choice of groups reagents &amp; group analysis. Interfering anions (Flurate, borate, oxalate &amp; phosphate),</li> </ol>	7



IV	<p><b>Quantitative Analysis:</b></p> <p>4.1 Quantitative Analysis-Definition &amp; types of Quantitative analysis</p> <p>4.2 Volumetric Analysis: Basic definitions, Types of titrations</p> <p>4.3 Gravimetric Analysis: Introduction, types of gravimetric analysis</p> <p>4.4 Steps in Gravimetry-Precipitation technique with respect to theory, Solubility consideration; common ion effect; diverse Ion effect; pH Temperature and nature of solubility, Digestion, Nucleation, co &amp; post precipitation, Filtration &amp; washing, Drying &amp; Ignition.</p>	7
	<p><b>Course Outcomes: After completion of the course students will be able to...</b></p> <ol style="list-style-type: none"> <li>1. Discuss principles of spectroscopy.</li> <li>2. Describe the electroanalytical methods of analysis.</li> <li>3. Apply fundamental methods of qualitative analysis to organic and inorganic compounds.</li> <li>4. Analyze the unknown compounds quantitatively.</li> </ol>	
	<p><b>References:</b></p> <ol style="list-style-type: none"> <li>1. Chatwal G. R., Anand S. 2011. Instrumental Methods of Chemical Analysis: Himalaya Publishing House.</li> <li>2. Svehla G., Sivasankar B. 2012. Vogel's Text Book of Qualitative Inorganic Analysis: Pearson Education India.</li> <li>3. Mendham J., Sivasankar B. 2009. Vogel's Text Book of Quantitative Chemical Analysis: Pearson Education India.</li> <li>4. Khopkar S. M. 2017. Basic Concepts in Analytical chemistry: New Age International Ltd.</li> <li>5. Sharma B. K. 2000. Industrial Chemistry: Goel publishing House, Meerut.</li> </ol>	

\*\*\*\*\*

Credits 2	Practical Course Major Lab III BCP - 233	No. of Hrs. 60
	<p><b>Course Objectives: Students should be able to...</b></p> <ol style="list-style-type: none"> <li>1. Train in practical course of qualitative analysis of organic compounds.</li> <li>2. Gain the knowledge of volumetric estimation and its application.</li> <li>3. Learn the preparation of organic compounds and its mechanism.</li> </ol>	
	<b>Experiments</b>	
	<ol style="list-style-type: none"> <li>1. Organic Qualitative Analysis (10 compounds).</li> <li>2. Determine the amount of acetone in the given solution.</li> <li>3. Determine the amount glycine from given solution.</li> <li>4. Determine the amount of ethyl benzoate in the given solution.</li> <li>5. Preparation of benzoic acid from benzamide.</li> <li>6. Preparation of p-nitro acetanilide from acetanilide.</li> <li>7. Preparation of Phthalimide from Phthalic anhydride.</li> <li>8. Preparation of dihydropyrimidone from benzaldehyde, ethyl acetoacetate and Urea.</li> <li>9. Preparation of Dibenzalpropanone from benzaldehyde and Acetone.</li> <li>10. Preparation of Orange II from sulphanilic acid.</li> <li>11. Check the progress of reaction by Thin Layer Chromatography.</li> </ol>	
	<p><b>Course Outcomes: After completion of the course students will be able to...</b></p> <ol style="list-style-type: none"> <li>1. Identify the organic compounds and their structures.</li> <li>2. Estimate the unknown compound concentration quantitatively.</li> <li>3. Perform small step preparations of industrially important compounds.</li> </ol>	
	<p><b>References:</b></p> <ol style="list-style-type: none"> <li>1. Pandey O. P., Bajpay D. N., Giri S. 2010. Practical Chemistry: For B. Sc. I, II and III Year Students of All India Universities: S Chand.</li> <li>2. Venkateswaran V. 2012. Basic Principles of Practical Chemistry: Sultan Chand and Sons.</li> <li>3. Vogel Arthur. 1989. Vogel's Text Book of Quantitative Analysis: Longman.</li> <li>4. Verma N. K., Vermani B. K., Verma N., Comprehensive Practical Chemistry: Laxmi Publication (P) LTD.</li> <li>5. Furniss B., Hannaford A., Smith P., Tatchell A. 1989. Vogel Practical Organic Chemistry: Longman Sci &amp; Technical, 5<sup>th</sup> edition.</li> </ol>	

Credits 2	Practical Course Major Lab IV BCP - 234	No. of Hrs. 60
	<p><b>Course Objectives: Students should be able to...</b></p> <ol style="list-style-type: none"> <li>Analyze the unknown samples qualitatively and quantitatively.</li> <li>Gain the knowledge of volumetric estimations and its application.</li> <li>Learn the handling of various analytical instruments for analysis.</li> </ol>	
	<b>Experiments</b>	
	<ol style="list-style-type: none"> <li>Verification of Beer- Lambert law for <math>\text{KMnO}_4</math> solution and to determine unknown concentration of a given solution of <math>\text{KMnO}_4</math> by colorimetry.</li> <li>Verification of Beer- Lambert law for <math>\text{K}_2\text{Cr}_2\text{O}_7</math> solution and to determine unknown concentration of a given solution by colorimetry.</li> <li>Determination of pH of given soil samples by using pH meter</li> <li>Determination of percentage of Vitamin C in the given Vitamin C Tablet.</li> <li>To carry out the assay of commercial sample of aspirin.</li> <li>Determination of titrable acidity in the given sample of milk using supplied sodium hydroxide.</li> <li>Determination of titrable acidity in the given sample of lassi using supplied sodium hydroxide.</li> <li>Determination of percentage purity of boric acid using supplied sodium hydroxide.</li> <li>Determination of nitrogen content in Urea fertilizer Sample.</li> <li>Determination of the value of chemical oxygen demand (C.O.D.) of a given water sample</li> <li>Analysis of DO in Waste Water Sample.</li> <li>Quantitative estimation of aniline.</li> <li>Quantitative estimation of Phenol.</li> <li>Estimation the amount of hydroxyl group by acylation method.</li> <li>Quantitative estimation of ethyl methyl ketone.</li> <li>Separation of food dyes using column chromatography. (Any four samples)</li> </ol>	
	<p><b>Course Outcomes: After completion of the course students will be able to...</b></p> <ol style="list-style-type: none"> <li>Estimate the substances to determine unknown amount in its solution.</li> <li>Conduct estimations quantitatively.</li> <li>Handle the various instruments for analysis.</li> </ol>	
	<p><b>References:</b></p> <ol style="list-style-type: none"> <li>Mendham J., Sivasankar B. 2009. Vogel's Text Book of Quantitative Chemical Analysis: Pearson Education India.</li> <li>Khopkar S. M. 2017. Basic concepts in Analytical Chemistry: New Age International Ltd.</li> <li>Sharma B. K., 2000. Industrial Chemistry: Goel publishing House, Meerut.</li> <li>Austin G. T., 2017. Shreve's Chemical Process Industries: MacGraw Hill, 5<sup>th</sup> Edition.</li> </ol>	

<b>B. Sc. Part II, Semester IV</b>		
<b>Credits 2</b>	<b>Course III: Physical Chemistry Course Code: BCT 241</b>	<b>No. of Hrs. 30</b>
	<p><b>Course Objectives: Students should be able to...</b></p> <ol style="list-style-type: none"> <li>1. Understand the basic concepts related to conductance.</li> <li>2. Learn the Galvanic cell, its types and applications of EMF measurement.</li> <li>3. Know the properties of liquids.</li> <li>4. Study the theories of reaction rates.</li> </ol>	
<b>Unit No.</b>	<b>Title and Syllabus</b>	<b>Hrs. Allotted</b>
<b>I</b>	<p><b>Electrochemistry Part I: Electrolytic Conductance and Transference:</b></p> <ol style="list-style-type: none"> <li>1.1 Electrolysis and Faraday's laws of Electrolysis, Conduction of electricity, and Types of conductors: Electronic and Electrolytic.</li> <li>1.2 Explanation of the terms: Specific, equivalent and molar conductance, relation between specific and equivalent conductance, variation of conductance with dilution, equivalent conductance at infinite dilution.</li> <li>1.3 Migration of ions, Hittorf's rule, Transport number, Determination of transport number by Moving boundary method, Factors influencing transport number: Nature of electrolyte, Concentration, Temperature, Complex formation, Abnormal transport number, Degree of hydration</li> <li>1.4 Kohlrausch law and application of conductance measurement:               <ol style="list-style-type: none"> <li>(1) Relationship between ionic conductance, ionic mobility and transport number.</li> <li>(2) Determination of equivalent / molar conductance at infinite dilution for weak electrolytes.</li> <li>(3) Determination of degree of dissociation.</li> <li>(4) Determination of ionic product of water.</li> <li>(5) Determination of solubility and solubility product of sparingly</li> </ol> </li> <li>1.5 Numerical problem</li> </ol>	<b>8</b>

II	<p><b>Electrochemistry Part II: Electromotive Force:</b></p> <p>2.1 Galvanic cells. Concept of EMF of a cell. Measurement of EMF of a cell. Standard electrode potential.</p> <p>2.2 Nernst equation and its importance.</p> <p>2.3 Types of electrodes: Metal/Metal ion electrode, Amalgam electrode, Gas electrode, Metal insoluble salt electrode, Oxidation reduction Electrode.</p> <p>2.4 Calculation of thermodynamic properties: <math>\Delta G</math>, <math>\Delta H</math> and <math>\Delta S</math> from EMF data. Calculation of equilibrium constant from EMF data. pH determination using hydrogen electrode and quinhydrone electrode.</p>	8
III	<p><b>Physical Properties of Liquids:</b></p> <p>3.1 Classification of physical properties.</p> <p>3.2 Viscosity, coefficient of viscosity, determination of viscosity by Ostwald's Viscometer.</p> <p>3.3 Refractive index, measurement of refractive index by Abbe's refractometer, specific and molecular refraction, molecular refractivity.</p> <p>3.4 Surface Tension: Surface tension and its determination using Stalagmometer and differential capillary rise method.</p> <p>3.5 Numerical problems.</p>	7
IV	<p><b>Chemical Kinetics:</b></p> <p>4.1 Third order reactions – derivation of rate constant, Characteristics of Third-order reactions, Examples of third order reaction.</p> <p>4.2 Effect of temperature on rate of reaction, Arrhenius equation, Concept of energy of activation.</p> <p>4.3 Theories of Reaction Rates: Collision theory and Activated Complex theory of bimolecular reactions.</p> <p>4.4 Numerical problems</p>	7
	<p><b>Course Outcomes: After completion of the course students will be able to...</b></p> <ol style="list-style-type: none"> <li>1. Describe the conductance and related terms.</li> <li>2. Construct the Galvanic cell and derives equation for emf of cells.</li> <li>3. Explain physical properties of liquids.</li> <li>4. Discuss the theories of reaction rates.</li> </ol>	
	<p><b>References:</b></p> <ol style="list-style-type: none"> <li>1. Puri B. R., Sharma L. R., Pathania M. S. 2013. Principles of Physical Chemistry: Vishal Publishing Company, 4<sup>th</sup> edition.</li> <li>2. Bahl B. S., Tuli G. D., 2010. Essentials of Physical Chemistry: S. Chand.</li> <li>3. Dash U. N., Darmarha U. N., Soni P. L., 2016. Text Book of Physical Chemistry: S. Chand &amp; Sons.</li> <li>4. Atkins P. W., Paula Julio de, 2012. Elements of Physical Chemistry: Oxford University Press.</li> <li>5. Dogra S. K., Dogra D., 1984. Physical Chemistry Through Problems, Wiley Eastern Ltd.</li> </ol>	

Credits 2	Course IV: Inorganic Chemistry Course Code: BCT 242	No. of Hrs. 30
	<b>Course Objectives: Students should be able to...</b> 1. Study the periodic properties of transition elements. 2. Know the characteristic properties of Lanthanides and Actinides. 3. Understand the difference between co-ordinate bond, double salts and complex salt. 4. Learn the chelation concept and its application.	
Unit No.	Title and Syllabus	Hrs. Allotted
I	<b>Elements of First Transition Series:</b> 1.1 Position of elements in periodic table 1.2 Characteristics of d-block elements with special reference to i) Electronic structure ii) Oxidation states iii) Magnetic character iv) Coloured ions v) Complex formation.	8
II	<b>Lanthanide and Actinides:</b> 2.1 Introduction of lanthanides, Objectives 2.2 General Features-Electronic Configuration, Oxidation states and ionic radii 2.3 Lanthanide contraction, Separation of Lanthanide. 2.4 Introduction of Actinides 2.5 General features-Electronic Configuration, Oxidation States and ionic radii.	8
III	<b>Co-ordination chemistry:</b> 3.1 Introduction-Definition and formation of co-ordinate covalent bond. 3.2 Distinction between double salt and complex salt 3.3 Werner's theory-Postulates and its applications to cobalt amines viz. $\text{CoCl}_3 \cdot 6\text{NH}_3$ , $\text{CoCl}_3 \cdot 5\text{NH}_3$ , $\text{CoCl}_3 \cdot 4\text{NH}_3$ , $\text{CoCl}_3 \cdot 3\text{NH}_3$ . 3.4 Description of the terms- ligand, co-ordination number, co-ordination sphere, Effective atomic number, 3.5 IUPAC nomenclature of coordination compounds 3.6 Introduction to Isomerism in complexes 3.7 Valence bond theory of transition metal complex with respect to, C.N. 4, complexes of Cu and Ni C.N. 6 complexes of Fe and Co 3.8 Crystal field splitting of 'd' orbital in octahedral, tetrahedral & square planar complexes. Factors affecting to the Crystal field parameters, High spin & low spin octahedral complexes of Co (II), Crystal field stabilization energy (CFSE), Limitations of CFT.	7

<p><b>IV</b></p>	<p><b>Chelation:</b></p> <p>4.1 A brief introduction with respect to ligands, chelating agent, chelation and metal chelates.</p> <p>4.2 Structural requirements of chelate formation, Difference between metal chelate and metal complex</p> <p>4.3 Classification of chelating agents (with specific illustration of bidentate chelating agents)</p> <p>4.4 Application of chelation with respect to chelating agents - EDTA and DMG</p>	<p><b>7</b></p>
	<p><b>Course Outcomes: After completion of the course students will be able to...</b></p> <ol style="list-style-type: none"> <li>1. Explain the characteristic properties of transition elements.</li> <li>2. Draw the electronic configuration of lanthanides and actinides.</li> <li>3. Differentiate between double salt and complex salt.</li> <li>4. Classify the various chelating agents and complexes.</li> </ol>	
	<p><b>References:</b></p> <ol style="list-style-type: none"> <li>1. Lee J. D. 2008. Concise Inorganic Chemistry: Oxford University Press.</li> <li>2. Gopalan R., Ramalingam V. Concise Co-ordination Chemistry: Vikas Publishing House Pvt. Ltd.</li> <li>3. Puri B. R., Sharma L. R., Kalia K. C. 2020. Principles of Inorganic Chemistry: Vishal Publishing Company.</li> <li>4. Kaur H. 2016. Instrumental Methods of Chemical Analysis: Pragati Prakashan Meerut.</li> <li>5. Sharma B. K., Industrial Chemistry: Goel publishing House, Meerut.</li> </ol>	

\*\*\*\*\*

Credits 2	Practical Course Major Lab V BCP - 243	No. of Hrs. 60
	<p><b>Course Objectives: Students should be able to...</b></p> <ol style="list-style-type: none"> <li>1. Study physical properties of liquid like viscosity, Refractive index and conductance etc.</li> <li>2. Understand the reaction rate equation and reaction rate constant, as well as the relationship between chemical reaction rates and reactant concentrations.</li> </ol>	
	<p><b>Part [A] :Instrumental</b></p> <ol style="list-style-type: none"> <li>1. <b>Viscosity:</b> <ol style="list-style-type: none"> <li>1. Determination of percentage composition of a given liquid mixture by viscosity method (Density data to be given).</li> <li>2. Determination of molecular mass of polystyrene from viscometry.</li> </ol> </li> <li>2. Determination of density of liquids by using specific gravity bottles.</li> <li>3. Determination of partition coefficient of acetic acid in water and cyclohexane.</li> <li>4. <b>Refractometry</b> :To determine the specific and molar refractions of benzene, toluene and xylene by Abbe's refractometer &amp; hence determination of the refraction of -CH<sub>2</sub>- group (Methylene group)</li> <li>5. <b>Conductometry:</b> <ol style="list-style-type: none"> <li>1. Determination of cell constant of a conductivity cell using standard KCl (N/10 or N/50) solutions</li> <li>2. Determination of degree of dissociation and dissociation constant of acetic acid at various dilutions and to verify Ostwald's dilution law conductometrically.</li> <li>3. Determination of the normality of the given strong acid by titrating it against strong alkali conductometrically.</li> <li>4. Determination of the normality of the given weak acid by titrating it against strong alkali conductometrically.</li> <li>5. Estimation of given acid by conductometric titration with strong base</li> <li>6. Determination of solubility and solubility product of BaSO<sub>4</sub>/ PbSO<sub>4</sub> at room temperature conductometrically.</li> </ol> </li> </ol> <p><b>Part [B]: Non-Instrumental</b></p> <p><b>6. Chemical Kinetics</b></p> <ol style="list-style-type: none"> <li>1 Study the hydrolysis of methyl acetate in presence of HCl and H<sub>2</sub>SO<sub>4</sub> and to determine the relative strength of acids.</li> <li>2 Study the effect of acid strength (0.5 M and 0.25 M HCl) on hydrolysis of an ester.</li> <li>3 Study the kinetics of the reaction between K<sub>2</sub>S<sub>2</sub>O<sub>8</sub> and KI in solution with unequal initial concentration of the reactants</li> <li>4 Study the reaction between potassium bromate and potassium iodide (KBrO<sub>3</sub> &amp; KI) in solution and hence to determine the order of the reaction.</li> </ol>	



	<p><b>Course Outcomes: After completion of the experiments students will be able to...</b></p> <ol style="list-style-type: none"> <li>1. Find viscosity, Refractive index and conductance etc. of given liquid samples</li> <li>2. Recall the conditions which affect the rate.</li> <li>3. Recognize the order of reaction and calculate the rate constant.</li> </ol>	
	<p><b>References:</b></p> <ol style="list-style-type: none"> <li>1. Pandey O. P., Bajpay D. N., Giri S. 2010. Practical Chemistry: For B. Sc. I, II and III Year Students of All India Universities:</li> <li>2. Chand S., Venkateswaran V. 2012. Basic Principles of Practical Chemistry: Sultan Chand and Sons.</li> <li>3. Vogel Arthur. 1989. Vogel's Text Book of Quantitative Analysis: Longman.</li> <li>4. Vogel Arthur, Bassett John. 1980. A Text Book of Quantitative Inorganic Analysis Including Elementary Instrumentation Analysis: Longman Sc and Tech.</li> <li>5. Verma N. K., Vermani B. K., Verma N., Comprehensive Practical Chemistry: Laxmi Publication (P) LTD.</li> <li>6. Arora C., Bhattacharya S., 2022. Advanced Physical Chemistry Practical Guide, ISBN: 978-1-68108-910-2 (Online).</li> <li>7. Satishkumar M., 2019. Practical Physical Chemistry, Sankalp Publication.</li> </ol>	

Credits 2	<p style="text-align: center;"><b>Practical Course</b> <b>Major Lab VI BCP – 244</b></p>	<p style="text-align: center;"><b>No. of Hrs.</b> <b>60</b></p>
	<p><b>Course Objectives: Students should be able to...</b></p> <ol style="list-style-type: none"> <li>1. Learn about the laboratory preparation methods of various inorganic compounds specially the coordination complex.</li> <li>2. Understand about the Complexometric titration.</li> <li>3. Learn how to perform the estimation of the various metal ions.</li> <li>4. Know the basic requirements for a suitable group reagent.</li> </ol>	
	<p><b>1 Gravimetric Analysis:</b></p> <ol style="list-style-type: none"> <li>1 Gravimetric estimation of iron as ferric oxide from the given solution of ferrous ammonium sulphate and free sulphuric acid.</li> <li>2 Gravimetric estimation of barium as barium sulphate from the given solution containing barium chloride and free hydrochloric acid</li> <li>3 Gravimetric estimation of Ni as Ni-DMG.</li> <li>4 Gravimetric estimation of Al as Al oxalate.</li> </ol> <p><b>2 Inorganic Preparations:</b></p> <ol style="list-style-type: none"> <li>1 Preparation of ferrous ammonium sulphate (Mohr's salt)</li> <li>2 Preparation of tetrammonium copper (II) sulphate</li> <li>3 Preparation of chloropentammine cobalt (III) chloride</li> <li>4 Preparation of Nickel dimethyl glyoximate using microscale method</li> <li>5 Preparation of Tris (ethylenediamine)nickel (II) thiosulphate</li> </ol> <p><b>3 Titrimetric Estimations:</b></p> <ol style="list-style-type: none"> <li>1. Determination of percentage purity of given sample of soda ash</li> <li>2. Determination of total hardness of water using 0.01M EDTA solution</li> <li>3. Determination on Percentage purity of tetrammine copper (II) Sulphate</li> <li>4. Estimation of (i) Mg<sup>2+</sup> or (ii) Zn<sup>2+</sup> by complexometric titrations using EDTA</li> <li>5. To determine volumetrically the amounts of sodium carbonate and sodium hydroxide present together in the given solution.</li> <li>6. To estimate H<sub>2</sub>O<sub>2</sub> by Iodometric method.</li> </ol> <p><b>4 Inorganic Semi-micro Qualitative Analysis: Analysis of Inorganic binary mixture : (Any five mixtures)</b>            Anions: Cl<sup>-</sup>, B<sup>-</sup>, NO<sub>3</sub><sup>-</sup>, NO<sub>2</sub><sup>-</sup>, SO<sub>4</sub><sup>-2</sup>, CO<sub>3</sub><sup>-2</sup>            Cations: Cd<sup>+2</sup>, Fe<sup>+2</sup>, Al<sup>+3</sup>, Cr<sup>+3</sup>, Zn<sup>+2</sup>, Mn<sup>+2</sup>, Co<sup>+2</sup>, Mg<sup>+2</sup>, K<sup>+</sup>, NH<sub>4</sub><sup>+</sup>, Ba<sup>+2</sup>, Cu<sup>+2</sup></p>	
	<p><b>Course Outcomes: After completion of the experiments, students will be able to:</b></p> <ol style="list-style-type: none"> <li>1. Estimate the amount of metal by gravimetric method.</li> <li>2. Prepare various inorganic compounds specially the coordination complex</li> <li>3. Standardize the solutions and use them for various titrations.</li> <li>4. Identify the radicals present in inorganic binary mixtures.</li> </ol>	

**References:**

1. Pandey O. P., Bajpay D. N., Giri S. 2010. Practical Chemistry: For B. Sc.I, II and III Year Students of All India Universities:
2. Chand S, Venkateswaran V. 2012. Basic Principles of Practical Chemistry: Sultan Chand and Sons.
3. Vogel Arthur. 1989. Vogel's Text Book of Quantitative Analysis: Longman.
4. Vogel Arthur, Bassett John. 1980. A Text Book of Quantitative Inorganic Analysis Including Elementary Instrumentation Analysis: Longman Sc and Tech.
5. Verma N. K., Vermani B. K., Verma N., Comprehensive Practical Chemistry: Laxmi Publication (P) LTD.

### Structure and Titles of Minor Course

Semester	Theory Course (Minor) Credits 4	Practical Course (Semester Wise) Credits 2
III	Course Code: BCT 235 Course I- Applied Chemistry-I	Course Code: BCP: 236 Minor Practical III
IV	Course Code: BCT 245 Course II- Applied Chemistry-II	Course Code: BCP : 246 Minor Practical V

#### Semester III

##### Course I: Applied Chemistry-I (BCT 235)

Subject	Unit No.	Title	Hrs.	Credits
<b>Organic and Analytical Chemistry</b>	I	Stereochemistry	<b>08</b>	<b>2</b>
	II	Aromaticity	<b>08</b>	
	III	Separation and Purification Techniques	<b>07</b>	
	IV	Unit Processes	<b>07</b>	
<b>Grand Total</b>			<b>30</b>	

#### Semester IV

##### Course II: Applied Chemistry-II (BCT 236)

Subject	Unit No.	Title	Hrs.	Credits
<b>Physical and Inorganic Chemistry</b>	I	Thermochemistry	<b>08</b>	<b>2</b>
	II	Thermodynamics	<b>08</b>	
	III	Hard and Soft Acids and Bases	<b>07</b>	
	IV	Bioinorganic Chemistry	<b>07</b>	
<b>Grand Total</b>			<b>30</b>	

Credits 2	Course I: Applied Chemistry-I Course Code: BCT – 235	No. of Hrs. 30
	<b>Course Objectives: Students should be able to...</b> 1. Learn stereochemistry of organic compounds and its applications. 2. Study the concept of aromaticity. 3. Understand the purification methods of various compounds. 4. Recall the unit processes.	
Unit No.	Title and Syllabus	Hrs. Allotted
I	<b>Stereochemistry:</b> 1.1 Introduction, types of stereoisomerism 1.2 Elements of Symmetry, Chiral and achiral compounds 1.3 Optical isomerism in tartaric acid, 2,3-dihydroxy butanoic acid, enantiomerism and diastereomerism 1.4 Geometrical isomerism: Geometrical isomerism in aldoxime & ketoximes, configuration of aldoximes & ketoximes 1.5 Nomenclature of stereoisomerisms DL, CIP rules: R/S, E and Z (cis trans), erythro and threo	8
II	<b>Aromaticity:</b> 2.1 Introduction to homocyclic and polycyclic aromatic hydrocarbons: benzene, naphthalene, anthracene 2.2 Meaning of important terms; aromatic, non aromatic, anti aromatic compounds 2.3 Huckel's rules and its applications 2.4 Aromatic electrophilic substitution reactions, effect of substitution Groups, General mechanism of electrophilic substitution reactions 2.5 Aromatic nucleophilic substitution (addition –elimination), orientation, activating & deactivating groups	8
III	<b>Separation and Purification Techniques:</b> 3.1 Distillation techniques, Distillation of liquid mixtures 3.2 Types of columns and packing, Condensers, Vacuum distillation, Spinning-band distillation, Steam distillation, Keigelrohr distillation, Isopiestic or isothermal distillation 3.3 Recrystallization Techniques 3.4 Filtration, Choice of solvents, Petroleum ethers, Mixed solvents 3.5 Sublimation	7
IV	<b>Unit Processes:</b> 4.1 Introduction 4.2 Reduction 4.3 Sulphonation of benzene 4.4 Halogenations of aromatic hydrocarbons 4.5 Nitration of benzene	7

	4.6 Polymerization	
	<p><b>Course Outcomes: After completion of the course students will be able to...</b></p> <ol style="list-style-type: none"> <li>1. Identify the different isomers and the related phenomenon.</li> <li>2. Classify the compounds as Aromatic, Anti-aromatic, Non-aromatic etc.</li> <li>3. Describe the separation and purification methods of the compounds depending on their physical state.</li> <li>4. Explain different unit processes of industrial importance.</li> </ol>	
	<p><b>References:</b></p> <ol style="list-style-type: none"> <li>1. Madan R. L. 2016. Chemistry for Degree student: S. Chand.</li> <li>2. Morrison &amp; Boyd, 2002. Organic Chemistry: Pearson Education, Prentice Hall of India, 6<sup>th</sup> Edition.</li> <li>3. Ahluwalia V. K., Parashar R. K. 2010. Organic Reaction Mechanism: Narosa Publishing House, 4<sup>th</sup> Edition.</li> <li>4. Mendham J., Sivasankar B. 2009. Vogel's Text Book of Quantitative Chemical Analysis: Pearson Education India,</li> <li>5. Khopkar S. M. 2017. Basic concepts in Analytical Chemistry: New Age International Ltd.</li> <li>6. Sharma B. K. 2000. Industrial Chemistry: Goel Publishing House, Meerut.</li> </ol>	

Credits 2	Practical Course Minor Lab III BCP - 236	No. of Hrs. 60
	<b>Course Objectives: Students should be able to...</b> 1. Study the qualitative analysis of organic compounds. 2. Explore the preparation of organic compounds and its mechanism. 3. Learn to perform the various unit processes and operations.	
	<b>Experiments</b>	
	1. Volumetric Analysis: Estimation of Aspirin. 2. Estimation of Acetamide/Aniline. 3. Organic Qualitative analysis of organic compounds (Any 10) 4. Preparations of derivatives of organic compounds 1.1 Nitration 1.2 Oximes of aldehydes & ketones 1.3 2,4-dinitrophenylhydrazone of aldehydes & ketones 1.4 Picrate 1.5 Oxalate 5. Preparation of benzoic acid from benzamide. 6. Preparation of p-Nitro acetanilide from acetamide. 7. Separation and identification of cation by paper chromatographic technique from the following mixtures i) $\text{Ni}^{2+} + \text{Cu}^{2+}$ , ii) $\text{Ni}^{2+} + \text{Co}^{2+}$ , iii) $\text{Cu}^{2+} + \text{Co}^{2+}$ 8. Identify & separate mixture of amino acids / sugar by paper chromatography. 9. Purification of compounds by crystallization using suitable solvents (Any two). 10. Purification of compounds by sublimation (Any two). 11. Purification of compounds by distillation (Any two).	
	<b>Course Outcomes: After completion of the course students will be able to...</b> 1. Perform the experiments to determine unknown amount of substance quantitatively. 2. Identify and separate the radicals from unknown inorganic binary mixture by chromatography 3. Purify and separate the various solid and liquid substances.	

**References:**

1. Pandey O. P., Bajpay D. N., Giri S. 2010. Practical Chemistry: For B. Sc. I, II and III Year Students of All India Universities: S Chand.
2. Venkateswaran V. 2012. Basic Principles of Practical Chemistry: Sultan Chand and Sons.
3. Vogel Arthur. 1989. Vogel's Text Book of Quantitative Analysis: Longman.
4. Verma N. K., Vermani B. K., Verma N., Comprehensive Practical Chemistry: Laxmi Publication (P) LTD.
5. Furniss B., Hannaford A., Smith P., Tatchell A. 1989. Vogel Practical Organic Chemistry: Longman Sci & Technical, 5<sup>th</sup> edition.



Credits 2	Course I: Applied Chemistry-II Course Code: BCT – 245	No. of Hrs. 30
	<p><b>Course Objectives: Students should be able to...</b></p> <ol style="list-style-type: none"> <li>1. Study the concept of entropy and its types.</li> <li>2. Learn the laws of thermodynamics and its applications to real systems.</li> <li>3. Understand the classification of acids and bases as hard and soft.</li> <li>4. Recall the role of inorganic elements in biological processes.</li> </ol>	
Unit No.	Title and Syllabus	Hrs. Allotted
I	<p><b>Thermochemistry:</b></p> <ol style="list-style-type: none"> <li>1.1 Introduction</li> <li>1.2 Enthalpy of reaction, Standard enthalpy change.</li> <li>1.3 Types of enthalpy changes viz: enthalpy of neutralization, enthalpy of ionization, enthalpy of formation, enthalpy of solution, enthalpy of hydration, enthalpy of phase transition.</li> <li>1.4 Calculation of bond energy, bond dissociation energy and resonance energy from thermo chemical data,</li> <li>1.5 Variation of enthalpy of reaction with temperature – Kirchoff's equation.</li> <li>1.6 Numerical problems</li> </ol>	8
II	<p><b>Thermodynamics:</b></p> <ol style="list-style-type: none"> <li>2.1 Introduction, Basic Terms</li> <li>2.2 Spontaneous and non-spontaneous process with examples, Statement of Second law of Thermodynamics, Carnot's cycle, its efficiency, Carnot's Theorem (Heat engine)</li> <li>2.3 Concept of entropy, physical significance of entropy. Entropy as a function of volume and temperature, pressure and temperature, entropy of mixing of gases, entropy change accompanying phase transition</li> <li>2.4 Third law of thermodynamics</li> <li>2.5 Numerical problems</li> </ol>	8
III	<p><b>Hard and Soft Acids and Bases (HSAB):</b></p> <ol style="list-style-type: none"> <li>3.1 Classification of acids and bases as hard and soft.</li> <li>3.2 Pearson's HSAB concept.</li> <li>3.3 Acid – Base strength and hardness and softness.</li> </ol>	7
IV	<p><b>Bioinorganic Chemistry:</b></p> <ol style="list-style-type: none"> <li>4.1 Introduction.</li> <li>4.2 Essential and trace elements in biological process.</li> <li>4.3 Metalloporphyrins with special reference to hemoglobin and myoglobin.</li> <li>4.4 Biological role of alkali and alkaline earth metal ions with special reference to Na<sup>+</sup>, K<sup>+</sup> and Ca<sup>2+</sup></li> </ol>	7

	<p><b>Course Outcomes: After completion of the course students will be able to...</b></p> <ol style="list-style-type: none"> <li>1. Explain the concept of enthalpy and its types.</li> <li>2. Discuss the applications of laws of thermodynamics to real systems.</li> <li>3. Classify the hard and soft acids and bases.</li> <li>4. Identify the role of chemical elements in biological processes.</li> </ol>	
	<p><b>References:</b></p> <ol style="list-style-type: none"> <li>1. Puri, Sharma &amp; Kalia. 2020. Principles of Inorganic Chemistry: Vishal Publishing Co.</li> <li>2. Chanda Manas. 2019. Atomic Structure and Chemical Bonding: International Publishing House Pvt. Ltd.</li> <li>3. Prasad, R. K. 2009. Quantum Chemistry: New Age Science.</li> <li>4. Huheey James, Keiter Allen, Keiter Richard, Medhi Okhil. 2014. Inorganic Chemistry, Principles of Structure and Reactivity: Pearson Education.</li> <li>5. Madan, R. D. 1987. Modern Inorganic Chemistry: S. Chand Ltd.</li> <li>6. Lee J. D. 2008. Concise Inorganic Chemistry 5<sup>th</sup> Edition: Wiley India Pvt. Ltd.</li> </ol>	

Credits 2	Practical Course Minor Lab IV BCP - 246	No. of Hrs. 60
	<b>Course Objectives: Students should be able to...</b> 1. Study the physical parameters such as pH, enthalpy, rate of reaction. 2. Gain the knowledge of volumetric estimation its application.	
	<b>Experiments</b>	
	1. Determination of Enthalpy of neutralization of hydrochloric acid with sodium hydroxide. 2. Determination of heat of ionization of weak acid by using polythene bottle. 3. Preparation of Buffer solutions Sodium Acetate –Acetic Acid and Ammonium chloride – Ammonium hydroxide and Measurement of pH of buffer solution & comparison of values with theoretical values 4. Measurement of pH of different solutions like aerated drinks, fruit juices, shampoos & soaps using pH meter. 5. Chemical Kinetics: To study the hydrolysis of methyl acetate. 6. Chemical Kinetics: To investigate the reaction between $K_2S_2O_8$ and KI with equal initial concentration of reactants. (Plotting of graph). 7. Equivalent weight: To determine equivalent weight of metal (Mg) by hydrogen displacement method using Eudiometer. 8. Determination of the percentage composition of liquid mixture by viscosity method. 9. Determination of cell constant of a conductivity cell using standard KCl (N/10 or N/50 KCl solution). 10. Determination of normality of given strong acid by titrating it against strong alkali conductometrically. 11. Gravimetric Analysis (volatilization gravimetric analysis) Binary Mixture 1) $NH_4Cl + BaSO_4$ 2) $ZnO + ZnCO_3$ 12. Gravimetric estimation of Fe as ferric oxide from the given solution of FAS and free sulphuric acid. 13. Preparation of standard 0.1 N $KMnO_4$ solution and determine the strength of given oxalic acid solution. 14. Determination of quantity of Fe (II) ions from the given solutions by titrating with 0.1 N $K_2Cr_2O_7$ solutions by using internal indicator. 15. Estimation of amount of Acetic acid from the given vinegar sample by titrimetric method.	

	<p>16. Determination of percentage purity of given sample of soda ash.</p> <p>17. Determination of percentage purity of given sample of tetraamine Cu (II) sulphate.</p> <p>18. Preparation of tetraamino Cu (II) sulphate.</p> <p>19. Preparation of ferrous ammonium sulphate (FAS).</p>	
	<p><b>Course Outcomes: After completion of the course students will be able to...</b></p> <ol style="list-style-type: none"> <li>1. Determine the physical parameters of various reactions such as pH, rate etc.</li> <li>2. Perform the estimations to determine unknown amount.</li> </ol>	
	<p><b>References:</b></p> <ol style="list-style-type: none"> <li>1. Pandey O. P., Bajpay D. N., Giri S. 2010. Practical Chemistry: For B. Sc. I, II and III Year Students of All India Universities: S Chand.</li> <li>2. Venkateswaran V. 2012. Basic Principles of Practical Chemistry: Sultan Chand and Sons.</li> <li>3. Vogel Arthur. 1989. Vogel's Text Book of Quantitative Analysis: Longman.</li> <li>4. Verma N. K., Vermani B. K., Verma N., Comprehensive Practical Chemistry: Laxmi Publication (P) LTD.</li> <li>5. Furniss B., Hannaford A., Smith P., Tatchell A. 1989. Vogel Practical Organic Chemistry: Longman Sci &amp; Technical, 5<sup>th</sup> edition.</li> </ol>	

Credits 2	Value Education Course Environmental Awareness for Chemistry Course Code: BCTVEC-II	No. of Hrs. 30
	<b>Course Objectives: Students should be able to...</b> <ol style="list-style-type: none"> <li>1. Understand the current environmental issues.</li> <li>2. Know the environmental laws and ethics to protect environment.</li> <li>3. Realize the sustainable goals.</li> <li>4. Learn the role of chemistry in sustainable development.</li> </ol>	
Unit No.	Title and Syllabus	Hrs. Allotted
I	<b>Environmental Issues:</b> <ol style="list-style-type: none"> <li>1.1 Pollution (Air, Water and Land),</li> <li>1.2 Fresh water overuse</li> <li>1.3 Natural disasters</li> <li>1.4 Fuel and Energy storage due to overuse</li> <li>1.5 Increase in wasteland, Biodiversity loss, Global warming and climate change</li> </ol>	08
II	<b>Environmental Laws and Ethics:</b> <ol style="list-style-type: none"> <li>2.1 Environmental Protection Act,</li> <li>2.2 Wildlife Protection Act,</li> <li>2.3 Forest Conservation Act,</li> <li>2.4 Prevention and Control of Pollution Act protection of ,from unsustainable to sustainable development,</li> <li>2.5 Responsibilities of an Environmentally aware citizen</li> </ol>	08
III	<b>Sustainable Development Goals:</b> <ol style="list-style-type: none"> <li>3.1 Definition, Concept and strategies of sustainable development,</li> <li>3.2 United Nation Conference on Environment and Development with special reference to agenda 21, CSR and sustainability,</li> <li>3.3 Clean development mechanism,</li> <li>3.4 Commission on sustainable development,</li> <li>3.5 The world summit on sustainable development, threats to sustainable development, principles of sustainable development</li> </ol>	07
IV	<b>Role of Chemistry in Meeting the Sustainable Development Goals:</b> <ol style="list-style-type: none"> <li>4.1 Green Chemistry Principles</li> <li>4.2 Study of different chemical reactions by using green chemistry principles.</li> <li>4.3 Green Methods in practicals-Use of Microkits in reactions, two burette system etc.</li> <li>4.4 Green Equipments for Energy saving-Applications of Sonicator, Fuming Hood, Ultrasonic Probe, ETP, Microwave,</li> </ol>	07

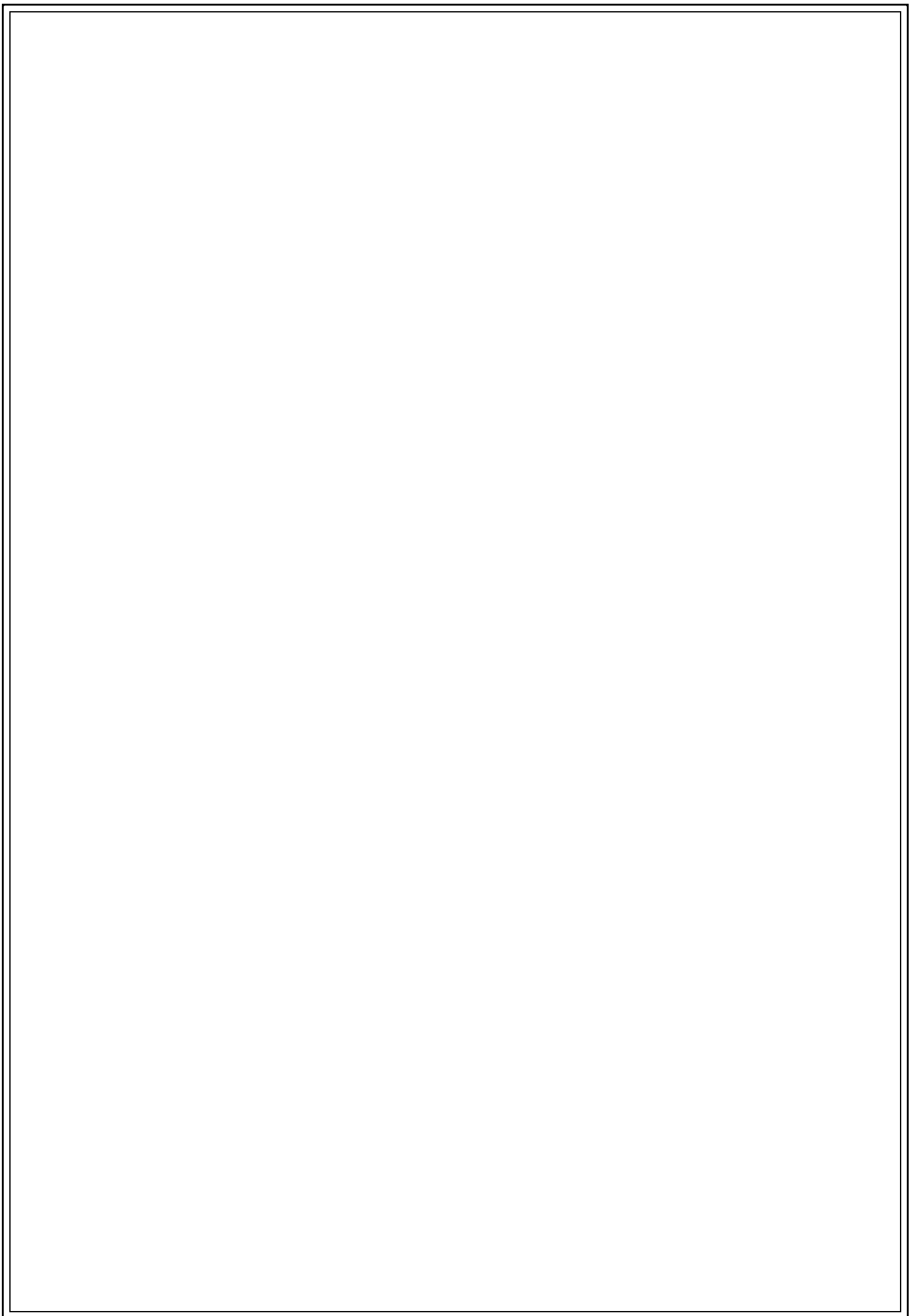
**Course Outcomes: After completion of the course students will be able to...**

1. Describe the various environmental issues.
2. Discuss and implement the environmental laws and ethics.
3. Implement sustainable goals in every practice related to environment.
4. Conduct the experiments using energy efficient equipment and green methods.

**References:**

1. A.K. De 2016. Environmental Chemistry: New Age Publisher International Pvt Ltd, 1<sup>st</sup> Edition
2. Watt, K.E.F. 1973. Principles of Environmental Science: McGraw-Hill Book Company.
3. Nobel, B.J., Kormandy, E.J. 1981. Environmental Science
4. Jude Wanniski 1998. The Way the World Works: Gateway Editions.
5. Turk A., Turk, J. Wittes J.T., Wittes, R.E. 1988. Environmental Science: Atlantic Books,
6. Anastas P. T., Warner J. C. 2005. Green Chemistry: Theory and Practice: OUP UK.
7. Sankar P. Dey, Nayim Sepay 2022. A Textbook of Green Chemistry: Techno World.

Credits 2	BCPSEC – II Water Quality Analyst Practical Course	No. of Hrs. 60
	<p><b>Course Objectives: Students should be able to...</b></p> <ol style="list-style-type: none"> <li>1. Study the collection and handling the various water samples.</li> <li>2. Learn the preparation of water samples for analysis.</li> <li>3. Study the different quality parameters of water analysis.</li> </ol>	
	<b>Experiments</b>	
	<ol style="list-style-type: none"> <li>1. Determination of odour and temperature of water sample.</li> <li>2. Determination of pH of water sample.</li> <li>3. Determination of redox potential of water sample.</li> <li>4. Determination of electrical conductivity of water sample.</li> <li>5. Determination of turbidity of water sample.</li> <li>6. Determination of Total Suspended Solids of water sample.</li> <li>7. Determination of Total Dissolved Solids of water sample.</li> <li>8. Determination of salinity of water sample.</li> <li>9. Determination of total acidity of water sample.</li> <li>10. Determination of total alkalinity of water sample.</li> <li>11. Determination of total hardness of water sample.</li> <li>12. Determination of sodium content of water sample.</li> <li>13. Determination of calcium content of water sample.</li> <li>14. Determination of potassium content of water sample.</li> <li>15. Determination of Aluminium in water sample.</li> <li>16. Determination of heavy metal content of water sample.</li> <li>17. Determination of total count of bacteria.</li> <li>18. Determination of E-Coli content of water sample.</li> <li>19. Determination of COD of water sample.</li> <li>20. Field Visit and project.</li> </ol>	
	<p><b>Course Outcomes: After completion of the experiments students will be able to...</b></p> <ol style="list-style-type: none"> <li>1. Handle the various samples of water for analysis.</li> <li>2. Measure the quality parameters of water such as pH, conductance, BOD, COD, TDS, Hardness etc.</li> <li>3. Perform the experiments using qualitative and quantitative methods of analysis.</li> </ol>	
	<p><b>References:</b></p> <ol style="list-style-type: none"> <li>1. Wagh G. S. 2017. Experimental Methods for Water Analysis: Nirali Prakashan, 2<sup>nd</sup> Edition.</li> <li>2. Gopinath V. R., Vanitha G. 2021. Systematic Methods of Water Quality Parameters Analysis: Analytical Methods: Partridge Publishing Singapore.</li> </ol>	





Credits 2	BCPSEC – III Soil Quality Analyst Practical Course	No. of Hrs. 60
	<p><b>Course Objectives: Students should be able to...</b></p> <ol style="list-style-type: none"> <li>1. Study the collection and handling the various soil samples.</li> <li>2. Learn the preparation of soil samples for analysis.</li> <li>3. Study the different quality parameters of soil analysis.</li> </ol>	
	<p><b>Experiments</b></p>	
	<ol style="list-style-type: none"> <li>1. Soil Profile study</li> <li>2. Visit to Soil Testing Laboratory &amp; Report writing.</li> <li>3. Visit to Farmers Fields for Collection of Soil Samples, identification of nutrient deficiency Symptoms in Crop.</li> <li>4. Preparation of Various Chemical reagents required for soil testing.</li> <li>5. Processing of Soil Sampling for analysis.</li> <li>6. Determination of PH of soil sample using PH meter</li> <li>7. Determination of Electrical Conductivity of Soil Sample using Electrical Conductivity meter.</li> <li>8. Determination of Organic Carbon by wet Oxidation method.</li> <li>9. Determination of available Nitrogen from Soil Sample.</li> <li>10. Determination of available phosphorus from soil sample.</li> <li>11. Determination of available Potassium from soil sample.</li> <li>12. Determination of Calcium Carbonate from soil sample.</li> <li>13. Determination of micronutrients from soil sample.</li> <li>14. Determination of Gypsum requirement of Soil.</li> <li>15. Preparation of soil test report, Interpretation of result and fertilizer recommendation.</li> <li>16. Preparation of soil test summaries and fertility maps.</li> <li>17. Preparation of Soil Health Card.</li> <li>18. Use of Various soil testing kits and working of mobile soil testing van.</li> <li>19. Determination of lime requirement of deictic soil.</li> <li>20. Field Visit and project.</li> </ol>	
	<p><b>Course Outcomes: After completion of the experiments students will be able to...</b></p> <ol style="list-style-type: none"> <li>1. Handle the various samples of soil for analysis.</li> <li>2. Measure the quality parameters of soil such as pH, conductance, fertility, productivity, heavy metal contamination etc.</li> <li>3. Perform the experiments using qualitative and quantitative methods of analysis.</li> </ol>	

	<b>References:</b>	
--	--------------------	--

- |  |  |  |
|--|--|--|
|  | 1. Wagh G. S. 2017. Soil Testing Manual: Nirali Prakashan, 1 <sup>st</sup> Edition.<br>2. Gupta I.C., Yaduvanshi N.P.S., Gupta S.K. 2020. Standard Methods of Analysis of Soil, Plant and Water: Scientific Publishers, 1 <sup>st</sup> Edition. |  |
|--|--|--|

Credits 2	Vocational Skill Course BCPVSC – I Food Quality Analyst Practical Course	No. of Hrs. 60
	<p><b>Course Objectives: Students should be able to...</b></p> <ol style="list-style-type: none"> <li>1. Study the collection and handling the various food samples.</li> <li>2. Study the different quality parameters of food adulteration and analysis.</li> <li>3. Understand the chemistry involved in the properties and reactions of various foods and its components.</li> </ol>	
	<b>Experiments</b>	
	<ol style="list-style-type: none"> <li>1. Collection and preservation of food samples for routine analysis.</li> <li>2. Determination of Protein from Biscuit.</li> <li>3. Determination of acidity of mild.</li> <li>4. Determination of Non Volatile Ether Extract of Chilli.</li> <li>5. Determination of B.R. of Groundnut oil.</li> <li>6. Determination of Ash and Acid insoluble ash of Turmeric.</li> <li>7. Determination of fiber content of poultry feed.</li> <li>8. Qualitative detection of adulterants in Atta, Maida, Besan, Biscuit, Black pepper, Butter, Ghee, Chilli, Powder, Honey, Tea, Turmeric powder, soft drink.</li> <li>9. M.B.R.T. of milk.</li> <li>10. Determination of Standard plate count of Milk Powder.</li> <li>11. Estimation of carbohydrates by Anthrone Reagent method.</li> <li>12. Estimation of starch.</li> <li>13. Estimation of crude fibre.</li> <li>14. Determination of Calorific value of food by Bomb Calorie Meter.</li> <li>15. Determination of Vitamin C by titration method.</li> <li>16. Determination of pigment.</li> <li>17. Estimation of Protein content by Lowry Methods.</li> <li>18. Test for adulterants in Sugar, Jaggery, Honey, Milk, Ghee, plantation crops (Tea, coffee), Turmeric, spices (Cardamom, cloves, pepper).</li> <li>19. Estimation of Cholesterol.</li> <li>20. Visits to different laboratories in the analytical field, exhibition, conference, workshop etc.</li> </ol>	

	<p><b>Course Outcomes: After completion of the experiments students will be able to...</b></p> <ol style="list-style-type: none"> <li>1. Handle the various samples of food for their safety analysis.</li> <li>2. Measure the adulteration of food using qualitative and quantitative methods of analysis.</li> <li>3. Demonstrate the properties of different food components and interactions among these components modulate the specific quality attributes of food systems.</li> </ol>	
	<p><b>References:</b></p> <ol style="list-style-type: none"> <li>1. A first course in food analysis By A.Y. Sathe.</li> <li>2. Hand book of analysis and quality control for fruit &amp; vegetable products by S. Ranganathan.</li> <li>3. Handling and storage of food grains By S.V. Pingale.</li> <li>4. Food science chemistry &amp; experimental food By Dr. M. Swaminathan.</li> <li>5. Food chemistry by William Hogland Meyer.</li> <li>6. Food adulteration By Thankamma Jacob.</li> <li>7. Food Microbiology by William C. frazier</li> <li>8. Preservation of Fruits and Vegetables By Giridhari lal.</li> <li>9. AOAC International, "Official methods of Analysis", AOAC International, 18th edition, Gaithersburg, Mary Land, 2007.</li> </ol>	

Credits 2	Vocational Skill Course Practical Course BCPVSC – II Fertilizer Technologist	No. of Hrs. 60
	<p><b>Course Objectives: Students should be able to...</b></p> <ol style="list-style-type: none"> <li>1. Master fertilizer analysis techniques for precise NPK content determination.</li> <li>2. Enhance titration skills to assess nitrogen levels in diverse fertilizer types.</li> <li>3. Acquire practical expertise in fertilizer used in agriculture and sampling of organic manure, solid and liquid fertilizers.</li> </ol>	
	<b>Experiments</b>	
	<ol style="list-style-type: none"> <li>1. Determination of total nitrogen in organic manure by Kjeldahl's method.</li> <li>2. Estimation of total nitrogen in plant sample.</li> <li>3. estimation of Zn in zinc sulphate.</li> <li>4. Determination of moisture from sludge fertilizer.</li> <li>5. Determination of moisture from organic fertilizer.</li> <li>6. Determination of nitrogen content in given ammonium chloride fertilizer by titration method.</li> <li>7. Determination of nitrogen content in given nitro-phosphate fertilizer by titration method.</li> <li>8. Determination of nitrogen content in given NPK fertilizer by titration method.</li> <li>9. Determination of nitrogen content in given vermin-compost fertilizer by titration method</li> <li>10. Study sampling of organic manure, solid and liquid fertilizers</li> <li>11. Study physical properties of organic manure and fertilizer.</li> <li>12. Estimation of ammonical and nitrate nitrogen in ammonical fertilizer</li> <li>13. Estimation of water soluble phosphate in single super phosphate (SSP)</li> <li>14. Determination of potassium in potassic fertilizers</li> <li>15. Estimation of calcium and magnesium in fertilizers by EDTA method</li> <li>16. Determination of sulphur in fertilizers by EDTA gravimetric method</li> <li>17. Use the dry type sieve to determine the particle diameter of Triple super phosphate.</li> <li>18. Determination of the particle diameter of NPK with a dry type sieving analysis.</li> <li>19. Use the dry type sieve to determine the particle diameter of Ammonium chloride.</li> </ol>	
	<p><b>Course Outcomes: After completion of the course students will be able to...</b></p> <ol style="list-style-type: none"> <li>1. Understand fertilizer analysis, especially nitrogen determination.</li> <li>2. Effectively apply titration for nitrogen quantification in diverse Fertilizers.</li> <li>3. Expertise in practical skills in agricultural chemistry and soil fertility management.</li> </ol>	

	<b>References:</b>	
--	--------------------	--

1. P. H. Smith and R. E. Johnson. 2003. Practical Guide to Fertilizers: Properties, Processes, and Applications. Wiley-Blackwell.
2. H.L.S. Tandon. 1996. Methods of Analysis of Soils, Plants, Waters, Fertilizers & Organic Manures. Fertilizer Development and Consultation Organisation.

Credits 2	Co-curricular Course BCTCC-II Village Services Through Volunteers	No. of Hrs. 30
	<b>Course Objectives: Students should be able to...</b> <ol style="list-style-type: none"> <li>1. Know the basic concepts of NSS.</li> <li>2. Inculcate the awareness and preparation of basic of social important goals.</li> <li>3. Improve personality.</li> <li>4. Understand the importance of chemicals and its managements through service.</li> </ol>	
Unit No.	Title and Syllabus	Hrs. Allotted
I	<b>Introduction to Basic Concept of NSS:</b> <ol style="list-style-type: none"> <li>1.1 Basic of NSS, the motto, Symbol, Badge, NSS song, aims and objective of NSS,</li> <li>1.2 Classification of NSS programme.</li> <li>1.3 Organizational structure, roles and responsibilities of various NSS functionaries.</li> </ol>	07
II	<b>NSS Programmes and Activities:</b> <ol style="list-style-type: none"> <li>2.1 NSS Regular activities in adopted villages, Slums and with Voluntary Organisations.</li> <li>2.2. Contributions of Special Camping Programm, Planning and preparation of special camping programme.</li> <li>2.3 Guidelines for the success of Camp.Importance of successful camping programme. Organization,</li> </ol>	08
III	<b>Chemistry of Health &amp; Hygiene Related Products:</b> <ol style="list-style-type: none"> <li>3.1 Introduction of medicines</li> <li>3.2 Chemistry of Vitamins and minerals</li> <li>3.3 Health insurance</li> <li>3.4 Hygiene and hygienic product</li> </ol>	07
IV	<b>Importance of Good Manners and Etiquettes:</b> <ol style="list-style-type: none"> <li>4.1 Factors affecting on personality: industrial approaches .</li> <li>4.2 Types of personalities: Extrovert and introvert.</li> <li>4.3 Dress code and punctuality.</li> <li>4.4 Use of disciplines and respect in greet people.</li> </ol>	08

	<p><b>Course Outcomes: After completion of the course students will be able to...</b></p> <ol style="list-style-type: none"><li>1. Apply NSS knowledge and Objectives.</li><li>2. Develop their interest in NSS and social servicing and its.</li><li>3. Participated in social activity</li><li>4. Realize the rural development by GO and NGO.</li></ol>	
	<p><b>References:</b></p> <ol style="list-style-type: none"><li>1. Ram Ahuja (2014) Social Problems In India: South Asia Books.</li><li>2. NSS HAND BOOK &amp; ACTION PLAN, (2017-18), Bharath University Chennai.</li><li>3. National Service Scheme Manual (Revised) 2006. Government of India, Ministry of Youth Affairs and Sports, New Delhi.</li><li>4. University of Mumbai National Service Scheme Manual 2009.</li><li>5. Avhan Chancellor's Brigade – NSS Wing, Training camp on Disaster Preparedness Guidelines, March 2012</li><li>6. S. Chakane, P. Pabrekar Rashtriya Seva Yojana Sankalpana: Diamond Publication, Pune.</li></ol>	