

Modern College of Arts, Science and Commerce (Autonomous),

Shivajinagar, Pune- 5

First Year of B. Sc. (Chemistry)

2024-25

Semester - I

Course Code	Course Name	No. of Credits
24ScCheU1101	Physical and Inorganic Chemistry (T)	02 Credits (30L)
24ScCheU1102	Lab course on 24ScCheU1101 (P)	02 Credits (15 Expt.)
24ScCheU1401	General Chemistry-I (T)	02 Credits (30L)
24ScCheU1601	Lab course on Basic Analytical Skill-I (P)	02 Credits (15 Expt.)
24ScCheU1901	Generic IKS (T)	02 Credits (30L)

Teaching Scheme: TH: Hours/Week : 4

Credit: 8

Examination Scheme: CIE : Marks 20

E.S.E : Marks 30

Prerequisite Courses:

- Knowledge of the periodic table
- Basic knowledge of mathematics
- Chemistry stoichiometric calculations
- Clear idea about chemical bonding
- Clear idea about different functional groups
- Elementary practical skills

Course Objectives:

- F.Y. B. Sc. Chemistry syllabus has been revised as per BOS directives.
- The content of the syllabus has been framed as per UGC norms.

- The students are expected to understand the fundamentals, principles, mathematical concepts and recent developments in the subject area.
- The practical course is in relevance to the theory courses to improve the understanding of the concepts.
- It is expected to enhance the interest of the students towards chemistry as the main subject.
- It would enable the development of an interdisciplinary approach of the subjects for students opting for specialization in other subjects at latter stages of graduation.

Course Outcomes:

- CO1 : Understand atomic structure, modern periodic table and periodic properties of elements.
- CO2: Understand the concept of chemical bonding .
- CO3: Learn chemistry of s and p block elementS.
- CO4: Understand concepts behind solid, liquid and gaseous states of matter.
- CO5: Calculate pH/pKa, degree of ionization, dissociation constant, solubility product of electrolytes

24ScCheU1101: Physical and Inorganic Chemistry (T)		(30 Lectures, 02 Credits)
Section I - Physical Chemistry		(01 Credit)
Chapter 1	Gaseous State	(06 Lectures)

	• Kinetic molecular model of a gas: postulates and derivation of the kinetic gas equation; collision frequency; collision diameter; mean free path and viscosity of gases, including their temperature and pressure dependence, relation between mean free path and coefficient of viscosity, calculation of σ from η; variation of viscosity with temperature and pressure. • Maxwell distribution and its use in evaluating molecular velocities (average, root mean square and most probable) and average kinetic energy, law of equipartition of energy, degrees of freedom and molecular basis of heat capacities. • Behaviour of real gases: Deviations from ideal gas behavior, compressibility factor, Z, and its variation with pressure for different gases. Causes of deviation from ideal behavior. van der Waals equation of state, its derivation and application in explaining real gas behavior.
Chapter 2	Liquid state (04 Lectures)
	• Qualitative treatment of the structure of the liquid state; Radial distribution function; physical properties of liquids; vapour pressure, surface tension and coefficient of viscosity, and their determination. Effect of addition of various solutes on surface tension and viscosity. Explanation of cleansing action of detergents. Temperature variation of viscosity of liquids and comparison with that of gases.

Chapter 3	Ionic equilibria	(5 Lectures)
	• Strong, moderate and weak electrolytes, degree of ionization, factors affecting degree of ionization, ionization constant and ionic product of water. Ionization of weak acids and bases, pH scale, common ion effect; dissociation constants of mono-, di-and triprotic acids (exact treatment). • Salt hydrolysis-calculation of hydrolysis constant, degree of hydrolysis and pH for different salts. Buffer solutions; derivation of Henderson equation and its applications; buffer capacity, buffer range, buffer action and applications of buffers in analytical chemistry and biochemical processes in the human body.	
Section II - Inorganic Chemistry		(01 Credit)
Chapter 1	Atomic Structure	(05 Lectures)

	• Bohr's theory, its limitations and atomic spectrum of hydrogen atom. • Wave mechanics: de Broglie equation, Heisenberg's Uncertainty Principle and its significance, Schrödinger's wave equation, significance of ψ and ψ^2. • Quantum numbers and their significance. • Normalized and orthogonal wave functions. • Sign of wave functions. Radial and angular wave functions for hydrogen atom. • Radial and angular distribution curves. Shapes of s, p, d and f orbitals. • Pauli's Exclusion Principle, Hund's rule of maximum multiplicity, Aufbau's principle and its limitations, Variation of orbital energy with atomic number.
Chapter 2	Periodicity of Elements (05 Lectures)

	• <i>s</i>, <i>p</i>, <i>d</i>, <i>f</i> block elements, the long form of periodic table. Detailed discussion of the following properties of the elements, with reference to <i>s</i> and <i>p</i>-block. • Effective nuclear charge, shielding or screening effect, Slater rules, variation of effective nuclear charge in periodic table. • Atomic radii (van der Waals) • Ionic and crystal radii. • Ionization enthalpy, Electron gain enthalpy, Electronegativity • Trends in acidic and basic nature of oxides of <i>p</i> block elements in group and in period. • Hydrides and halides of <i>p</i> block elements
Chapter 3	Chemical Bonding (05 Lectures)

	• <i>Ionic bond</i>: General characteristics, types of ions, size effects, radius ratio rule and its limitations. Packing of ions in crystals. Born-Landé equation with derivation and importance of Kapustinskii expression for lattice energy. Madelung constant, Born-Haber cycle and its application, Solvation energy. • <i>Covalent bond</i>: Lewis structure, Valence Bond theory (Heitler-London approach). Energetics of hybridization, equivalent and non-equivalent hybrid orbitals. Bent's rule, Resonance and resonance energy, • Formal charge, Valence shell electron pair repulsion theory (VSEPR), shapes of simple molecules and ions containing lone pairs and bond pairs of electrons, multiple bonding (σ and π bond approach) and bond lengths.
--	--

Reference Books:

Section I

- Atkins, P. W. & Paula, J. de *Atkin's Physical Chemistry* 10th Ed., Oxford University Press (2014).
- Ball, D. W. *Physical Chemistry* Thomson Press, India (2007).
- Castellan, G. W. *Physical Chemistry* 4th Ed. Narosa (2004).
- Mortimer, R. G. *Physical Chemistry* 3rd Ed. Elsevier: NOIDA, UP (2009).
- Engel, T. & Reid, P. *Physical Chemistry* 3rd Ed. Pearson (2013).
- Elements of Physical Chemistry Ed 2nd by Samuel Glasstone

Section II

- Lee, J. D. *Concise Inorganic Chemistry* ELBS, 1991.

- Douglas, B. E. and McDaniel, D. H. *Concepts & Models of Inorganic Chemistry* Oxford, 1970.
- Atkins, P. W. & Paula, J. *Physical Chemistry*, 10th Ed., Oxford University Press, 2014.
- Day, M. C. and Selbin, J. *Theoretical Inorganic Chemistry*, ACS Publications, 1962.
- Rodger, G. E. *Inorganic and Solid State Chemistry*, Cengage Learning India Edition, 2002.
- Cotton and Wilkinson's Advanced Inorganic Chemistry

Course Outcomes

- CO1: Understand the procedure of the experiments.
- CO2: Calculate and describe the results of the experiment.
- CO3: Interpret the major findings and draw an outline
- CO4: Understand Physical Chemistry Viscometer.
- CO5: Understand Inorganic volumetric analysis and Qualitative Analysis:

24ScCheU1102: Lab course on 24ScCheU1101 (P)		(16 Experiments, 02 Credits)
Section I	Physical Chemistry Practicals	(08 Experiments)

	A. Surface tension measurements. 1) Determine the surface tension by (i) drop number (ii) drop weight method. 2) Study the variation of surface tension of detergent solutions with concentration. B. Viscosity measurement using Ostwald's viscometer. 1) Determination of viscosity of aqueous solutions of (i) polymer (ii) ethanol and (iii) sugar at room temperature. 2) Study the variation of viscosity of sucrose solution with the concentration of solute. C. Indexing of a given powder diffraction pattern of a cubic crystalline system. D. pH metry 1) Study the effect on pH of addition of HCl/NaOH to solutions of acetic acid, sodium acetate and their mixtures. 2) Preparation of buffer solutions of different pH i. Sodium acetate-acetic acid ii. Ammonium chloride-ammonium hydroxide 3) pH metric titration of (i) strong acid vs. strong base, (ii) weak acid vs. strong base. 4) Determination of dissociation constant of a weak acid. <i>Any other experiment carried out in the class.</i>
Section II	Inorganic Chemistry Practicals (08 Experiments)

	A) Titrimetric Analysis 1) Calibration and use of apparatus 2) Preparation of solutions of different Molarity/Normality of titrants B) Acid-Base Titrations 1) Estimation of carbonate and hydroxide present together in mixture. 2) Estimation of carbonate and bicarbonate present together in a mixture. 3) Estimation of free alkali present in different soaps/detergents C) Oxidation-Reduction Titrimetry 1) Estimation of Fe(II) and oxalic acid using standardized KMnO_4 solution. 2) Estimation of oxalic acid and sodium oxalate in a given mixture. 3) Estimation of Fe(II) with $\text{K}_2\text{Cr}_2\text{O}_7$ using internal (diphenylamine, anthranilic acid) and external indicator.
--	--

Reference Books:

- Mendham, J., A. I. Vogel's *Quantitative Chemical Analysis* 6th Ed., Pearson, 2009.
- Khosla, B. D.; Garg, V. C. & Gulati, A. *Senior Practical Physical Chemistry*, R. Chand & Co.: New Delhi (2011).
- Garland, C. W.; Nibler, J. W. & Shoemaker, D. P. *Experiments in Physical Chemistry* 8th Ed.; McGraw-Hill: New York (2003).

- Halpern, A. M. & McBane, G. C. *Experimental Physical Chemistry 3rd Ed.*; W.H. Freeman & Co.: New York (2003).

Course Outcomes:

CO1: Label the basic parts of digestive organs and recall their functions. Remember the food regulation laws. Define terminologies related to nutrition.

CO2: Analyze the nutrients. Interpret the results of qualitative and quantitative analysis of components in food.

CO3: Define chemical terms of commercial items used in daily life and its features.

CO4: Explain the principles and procedures involved in the manufacturing process of daily use products.

24ScCheU1401: General Chemistry -I (T) (30 Lectures, 02 Credits)	
Chapter 1	Chemistry in day to day life (8 Lectures)
	• Household Chemicals: Common chemicals used at home. • Tooth paste – Contents of toothpaste, chemical name, ingredients, flavor and its role. • Cosmetics – Contents and uses of Face powder, snow, lipsticks and perfumes. Toxic household chemicals and their effects (antifreeze, bleach, drain cleaners, carpet cleaners, ammonia, air fresheners). • Soaps and detergents- Types of soaps, synthetic detergents (neutral, anionic and cationic), cleansing action of detergents. Advantages and disadvantages of detergents over soaps.

Chapter 2	Chemistry in human behavior	(5 Lectures)
	• Neurochemicals and their role in happiness (Oxytocin, Endorphins, Serotonin, Dopamine, Estrogens, Progesterone).	
Chapter 3	Food chemistry	(6 Lectures)
	• Food preservatives like benzoates, propionates, sorbates, disulphites. • Artificial sweeteners: Aspartame, saccharin, dulcin, sucralose and sodium cyclamate. • Flavors: Vanillin, alkyl esters (fruit flavors) and monosodium glutamate. • Artificial food colorants: Coal tar dyes, permitted and non-permitted colors.	
Chapter 4	Prohibition of Drugs & Narcotics	(8 Lectures)
	• Drugs and their classification • Therapeutic action of different classes of the drugs viz. analgesics, antibiotics, antacids, antihistamines, antimicrobials, contraceptives, antipyretics, antiseptics. • Introduction to narcotic with examples (Heroin, Morphine, Cocaine) LSD stamps • Narcotics Control Bureau (NCB) • NDPS Act (Offences & Penalties)	
Chapter 5	Kitchen Chemistry	(3 Lectures)

	• Introduction • Processes (Heating, Boiling, Freezing, Mixing, Smashing, Blending etc.), • Kitchen chemicals
--	---

Reference Books:

- NCERT Standard Book and references therein.
- Chemistry in Daily Life: Third Edition Paperback – 1 January 2012 by Singh K.
- International Journal of Science and Research (IJSR) ISSN: 2319-7064, DOI: 10.21275/SR20904163020
- Forensic Pharmacy by Dr. B. S. Kuchekar
- Forensic Pharmacy by B. M. Mittal

Course Outcomes:

CO1: Prepare solutions of different concentrations for different estimations.

CO2: Learn the extraction of various components present in the soil.

CO3: Analyze and apply different methods for soil and water.

CO4: Apply analytical methods for sampling ,titrations ,separations and interpret the results for chemical analysis of soil and water.

24ScCheU1601: Lab course on Basic Analytical Skill-I (P)
(15 Experiments, 02 Credits)

	1) Estimation of Calcium and Magnesium ions as Calcium Carbonates by complexometric titration from water. 2) Estimation of Alkalinity of a water sample. 3) Estimation of soluble chlorides in water samples. 4) Determination of Hardness in a water sample. 5) Determination of Chemical Oxygen Demand (COD) of a polluted water sample. 6) Determination of organic matter content in a soil sample. 7) Determination of calcium carbonate in soil. 8) Determination of Nitrogen-Alkaline Permanganate method.(distillation)
--	--

Reference Books:

1. Directorate of Irrigation Research & Development *Laboratory testing procedure for soil and water sample analysis*, Water and Resource Department, Government of Maharashtra, 2009
2. S.K Singh, B. Lal, and B. Devi Practical Manual *Fundamentals of Soil Science*, 2019.

Semester - II

Course Code	Course Name	No. of Credits
24ScCheU2101	Physical & Organic Chemistry (T)	02 Credits (30L)
24ScCheU2102	Lab Course on 24ScCheU2101 (P)	02 Credits (15 Expt.)
24ScCheU2401	General Chemistry - II (T)	02 Credits (30L)
24ScCheU2601	Lab Course on Basic Instrumentation Skills - II (P)	02 Credits (15 Expt.)
Course Outcome • CO1 :Explain the basic concepts and principles of organic and inorganic Chemistry. • CO2: Understand the structural effects and reactivity of organic compounds • CO3: Predict the product of different organic reactions. • CO4: Understand the concepts of chemical thermodynamics,		
24ScCheU2101: Physical & Organic Chemistry (T)		(30 Lectures , 02 Credits)
Section I -Physical Chemistry		(01 Credit)
Chapter 1	Chemical Thermodynamics	(11 Lectures)

	• <i>First law:</i> Concept of heat, q, work, w, internal energy, U, and statement of first law; enthalpy, H, relation between heat capacities, calculations of q, w, U and H for reversible, irreversible and free expansion of gases (ideal and van der Waals) under isothermal and adiabatic conditions. • <i>Second Law:</i> Concept of entropy; thermodynamic scale of temperature, statement of the second law of thermodynamics; molecular and statistical interpretation of entropy. Calculation of entropy change for reversible and irreversible processes. • <i>Third Law:</i> Statement of third law, concept of residual entropy, calculation of absolute entropy of molecules. • <i>Free Energy Functions:</i> Gibbs and Helmholtz energy; variation of S, G, A with T, V, P; Free energy change and spontaneity. inversion temperature.
Chapter 2	Chemical Equilibrium (04 Lectures)

	• Criteria of thermodynamic equilibrium, degree of advancement of reaction, chemical equilibria in ideal gases, concept of fugacity. • Thermodynamic derivation of relation between Gibbs free energy of reaction and reaction quotient. Coupling of exoergic and endoergic reactions. • Equilibrium constants and their quantitative dependence on temperature, pressure and concentration. • Free energy of mixing and spontaneity; thermodynamic derivation of relations between the various equilibrium constants K_p, K_c and K_x. Le Chatelier principle (quantitative treatment); equilibrium between ideal gases and a pure condensed phase.
Section II - Organic Chemistry	
(01 Credit)	
Chapter 1	Stereochemistry
(05 Lectures)	

	• Fischer Projection, Newmann and Sawhorse Projection formulae and their interconversions; • Geometrical isomerism: cis–trans and, syn-anti isomerism E/Z notations with C.I.P rules. • <i>Optical Isomerism:</i> Optical Activity, Specific Rotation, Chirality/Asymmetry, Enantiomers, Molecules with two or more chiral-centers, Diastereoisomers, meso structures, Racemic mixture and resolution. Relative and absolute configuration: D/L and R/S designations.
Chapter 2	Chemistry of Aliphatic Hydrocarbons (07 Lectures)

	A. Hybridization, Shapes of molecules, Influence of hybridization on bond properties. B. Homolytic and Heterolytic fission with suitable examples. Curly arrow rules, formal charges; Electrophiles and Nucleophiles; Nucleophilicity and basicity; Types, shape and their relative stability of Carbocations, Carbanions, Free radicals and Carbenes. • Chemistry of alkanes: Formation of alkanes, Wurtz Reaction, Wurtz-Fittig Reactions, Free radical substitutions: Halogenation - relative reactivity and selectivity. • Chemistry of alkenes: Formation of alkenes and alkynes by elimination reactions, Mechanism of E1, E2, E1cb reactions. Saytzeff and Hofmann eliminations. • <i>Reactions of alkenes:</i> Electrophilic additions their mechanisms (Markovnikov/ Anti Markownikoff addition), mechanism of oxymercuration-demercuration, hydroboration-oxidation, ozonolysis, reduction (catalytic and chemical), syn and anti-hydroxylation (oxidation). 1,2-and 1,4-addition reactions in conjugated dienes and, Diels-Alder reaction; Allylic and benzylic bromination and mechanism, e.g. propene, 1-butene, toluene, ethyl benzene. • <i>Chemistry of alkynes:</i> Acidity, Electrophilic and Nucleophilic additions. Hydration to form carbonyl compounds, Alkylation of terminal alkynes.
--	--

Chapter 3	Aromatic Hydrocarbons (03 Lectures)
	• <i>Aromaticity</i>: Hückel's rule, aromatic character of arenes, cyclic carbocations/carbanions and heterocyclic compounds with suitable examples. Electrophilic aromatic substitution: halogenation, nitration, sulphonation and Friedel-Craft's alkylation/acylation with their mechanism. Directing effects of the groups.

Reference Books:

Section-I

- Peter, A. & Paula, J. de. *Physical Chemistry* 10th Ed., Oxford University Press (2014).
- Castellan, G. W. *Physical Chemistry* 4th Ed., Narosa (2004).
- Engel, T. & Reid, P. *Physical Chemistry* 3rd Ed., Prentice-Hall (2012).
- McQuarrie, D. A. & Simon, J. D. *Molecular Thermodynamics* Viva Books Pvt. Ltd.: New Delhi (2004).
- Assael, M. J.; Goodwin, A. R. H.; Stamatoudis, M.; Wakeham, W. A. & Will, S.
- *Commonly Asked Questions in Thermodynamics*. CRC Press: NY (2011).
- Levine, I.N. *Physical Chemistry* 6th Ed., Tata Mc Graw Hill (2010).
- Metz, C.R. *2000 solved problems in chemistry*, Schaum Series (2006).

Section – II

- Morrison, R. N. & Boyd, R. N. *Organic Chemistry*, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
- Finar, I. L. *Organic Chemistry (Volume 1)*, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
- Finar, I. L. *Organic Chemistry (Volume 2: Stereochemistry and the Chemistry of Natural Products)*, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
- Eliel, E. L. & Wilen, S. H. *Stereochemistry of Organic Compounds*, Wiley: London, 1994.
- Kalsi, P. S. *Stereochemistry Conformation and Mechanism*, New Age International, 2005.

- McMurry, J.E. *Fundamentals of Organic Chemistry*, 7th Ed. Cengage Learning India Edition, 2013.

Course Outcomes:

CO1: To learn the basic concepts and principles through practical.

CO2: Perform the different techniques of purification improving the practical skills.

CO3: Understanding the concept of melting and boiling points of the compounds.

CO4: Relating the theoretical concepts in thermodynamics to various systems.

CO5: Understanding the separation techniques and its importance in organic chemistry.

CO6: Exploring the concept of enthalpy

24ScCheU2102: Lab Course on 24ScCheU2101 (P) (16 Experiments, 02 Credits)	
Section I	Physical Chemistry Practicals (08 Experiments)
	Thermochemistry 1) Determination of heat capacity of a calorimeter for different volumes using change of enthalpy data of a known system (method of back calculation of heat capacity of calorimeter from known enthalpy of solution or enthalpy of neutralization). 2) Determination of heat capacity of the calorimeter and enthalpy of neutralization of hydrochloric acid with sodium hydroxide. 3) Calculation of the enthalpy of ionization of ethanoic acid. 4) Determination of heat capacity of the calorimeter and integral enthalpy (endothermic and exothermic) solution of salts. 5) Determination of basicity/proticity of a polyprotic acid by the thermochemical method in terms of the changes of temperatures observed in the graph of temperature versus time for different additions of a base. Also calculate the enthalpy of neutralization of the first step. 6) Determination of enthalpy of hydration of copper sulphate. 7) Study of the solubility of benzoic acid in water and determination of ΔH. <i>Any other experiment carried out in the class.</i>
Section II	Organic Chemistry Practicals (08 Experiments)

	1) Checking the calibration of the thermometer 2) Purification of organic compounds by crystallization using the following solvents: a) Water b) Alcohol c) Alcohol-Water 3) Determination of the melting points of above compounds and unknown organic compounds (Kjeldahl method and electrically heated melting point apparatus) 4) Effect of impurities on the melting point – mixed melting point of two unknown organic compounds 5) Determination of boiling point of liquid compounds. (boiling point lower than and more than 100 °C by distillation and capillary method) 6) Chromatography: a) Separation of a mixture of two amino acids by ascending and horizontal paper chromatography b) Separation of a mixture of two sugars by ascending paper chromatography c) Separation of a mixture of o-and p-nitrophenol or o-and p-aminophenol by thin layer chromatography (TLC)
--	---

Reference Books

- Mann, F.G. & Saunders, B.C. *Practical Organic Chemistry*, Pearson Education (2009)

- Furniss, B.S.; Hannaford, A.J.; Smith, P.W.G.; Tatchell, A.R. *Practical Organic Chemistry*, 5th Ed., Pearson (2012)
- Khosla, B. D.; Garg, V. C. & Gulati, A., *Senior Practical Physical Chemistry*, R. Chand & Co.: New Delhi (2011).
- Athawale, V. D. & Mathur, P. *Experimental Physical Chemistry* New Age International: New Delhi (2001).

24ScCheU2401: General Chemistry - II (T)		(30 Lectures, 02 Credits)
Chapter 1	Chemistry Of Air	(6 Lectures)
	• Composition of air, • Sources of air pollution- Particulate matters, smog formation, CFC- Ozone depletion, Greenhouse effect, acid rain, • Pollution control, • Air quality index, • Effect of Air pollution, • Control of air pollution, • Air quality standard.	
Chapter 2	Chemistry Of Soil	(8 Lectures)

	• Introduction: Definition of soil, • Soil Components, Formation of Soil, • Types of soils & basic concepts, • Physical properties of Soil: temperature and color, density, aeration and drainage, soil water relationships, • Chemical Properties of soil: pH, acidity, alkalinity. • Soil pollution, Control of soil pollution.
Chapter 3	Water Chemistry (8 Lectures)
	• Water cycle, aquatic pollution and water quality parameters – Dissolved oxygen, biochemical oxygen demand, chemical oxygen demand, • Treatment of municipal water and wastewater, • Control of water pollution. • Water quality standard ,(CPCB).
Chapter 4	Fuel Chemistry With Energy Sources (8 Lectures)
	• Solid, liquid and gaseous fuels, • Calorific value of solid, liquid and gaseous fuels, • Flash point and fire point, • Renewable energy sources (Solar, Wind, Small hydro, Biomass, Geothermal and Ocean energy etc.).

Reference Books:

- De.A.K.Environmental Chemistry, Wiley Eastern Ltd, 1990.
- Miller T.G.Jr., Environmental Science,Wadsworth Publishing House, MeerutOdum.E.P.1971.
- S. E. Manahan, Environmental chemistry, 1993, Boca Raton, Lewis publisher.
- Environmentalchemistry, Sharma and Kaur, 2016, Krishna publishers.
- Environmental Pollution, Monitoring and control, S.M. Khopker, 2007, New Age International.
- Environmental chemistry, C. Baird, M. Cann, 5thEdn, 2012, W.H.Freeman publication.
- G. S. Sodhi Fundamental Concepts of Environmental Chemistry (Third Edition) Narosa (2009).

24ScCheU2601: Lab Course on Basic Instrumentation Skills - II (P) (15 Experiments, 02 Credits)	
	1) Determination of pH of water samples. 2) Determination of pH of Soil samples. 3) Determination of conductance of water samples. 4) Determination of conductance of soil samples. 5) Determination of available Sulphur in a soil sample.(colorimeter) 6) Determination of available phosphorus in a soil sample.(colorimeter) 7) Determination of organic matter content in a soil sample.(colorimeter)

Reference Books:

- Directorate of Irrigation Research & Development *Laboratory testing procedure for soil and water sample analysis*, Water and Resource Department, Government of Maharashtra, 2009
- S. K Singh, B. Lal, and B. Devi Practical Manual *Fundamentals of Soil Science*, 2019.

XX