


Progressive Education Society's

Modern College of Arts, Science and Commerce, Ganeshkhind, Pune-411016, India

(Autonomous)

(Affiliated to Savitribai Phule Pune University)

B. Sc. Blended

A

Degree Program

In collaboration with

University of Melbourne, Australia

and

Savitribai Phule Pune University, Pune-411007, India

T. Y. B. Sc. Blended (Semester V & VI)

Major: Chemistry Minor: Biology

Syllabus and Course structure

Choice Based Credit System (CBCS)
NEP-Version I
from
Academic Year 2025-26

T.Y.B.Sc.Blended Credit Framework
To be implemented from academic year 2025 - 2026

The electives and VSC can be changed and taken from general B.Sc.(Chemistry/Microbiology/Zoology/Mathematics/Statistics), B.Sc. Computer Science and B.Sc. Biotechnology. The students can also select it from the common basket.

Semester 5	**T.Y.B.Sc.Blended Semester V (NEP Version I)**			
Course Code	**Course Name**	**Credits**	**NEP vertical**	**Type of course**
CHM 501	Reaction Dynamics & Quantum Chemistry	2	DSC	Theory
CHM 502	Catalysis & Industrial Processes	2	DSC	Theory
CHM 503	Design & Synthesis of Organic Molecules	2	DSC	Theory
CHM 504	Introduction to Analytical Chemistry	2	DSC	Theory
CHM 505	Physical & Analytical Chemistry - LAB-1	2	DSC	Practical
CHM 506	Inorganic & Organic Chemistry - LAB-2	2	DSC	Practical
CHM 507	Green Chemistry #	2	DSE	Theory
CHM 508	Green Chemistry Practical #	2	DSE	Practical
CHM 509	Introduction to Forensic Science & Technology #	2	VSC	Theory (T/P)
BIO501	Biomolecules: Structure & Significance	2	Minor	Theory
IDC501	Field Project/Community Engagement and Services	2	FP/CEP	Practical
	Total credits	**22**		
Semester 6	**T.Y.B.Sc.Blended Semester VI (NEP Version I)**			
Course Code	**Course Name**	**Credits**	**NEP vertical**	**Type of course**
CHM 601	Solid State Chemistry & its Applications	2	DSC	Theory
CHM 602	Bioinorganic & Coordination Chemistry	2	DSC	Theory
CHM 603	Natural product & Heterocyclic Chemistry	2	DSC	Theory
CHM604	Advanced Analytical Techniques	2	DSC	Theory
CHM 605	Physical & Analytical Chemistry - LAB-2	2	DSC	Practical
CHM 606	Inorganic & Organic Chemistry - LAB-2	2	DSC	Practical
CHM 607	Agricultural Chemistry #	2	DSE	Theory
CHM 608	Agrochemistry Practical #	2	DSE	Practical
CHM609	Materials Chemistry #	2	VSC	Theory (T/P)
IDC 601	Project/On Job Training	4	OJT	Practical
	Total credits	**22**		

Detail syllabus is from the next page

SEMESTER V

Course Code: CHM501 **Number of Credits**: 2

Course Name: Reaction Dynamics & Quantum Chemistry **Type:** Theory

NEP Vertical: Discipline Specific Course (DSC) **Number of lectures:** 30

CHM 501- Reaction Dynamics & Quantum Chemistry	
CO1: The student should be able to understand the chemical kinetics and its applications CO2: The student should be able to understand the concepts in photochemical reaction and its applications CO3: The student should be able to understand the concepts in molecular thermodynamics and its applications CO4: The student should be able to understand the concepts in quantum chemistry and its applications	
Chemical Kinetics (10 lectures)	
• Order, molecularity, Factors affecting on reaction rates, optimum pH and optimum temperature • rate laws – 1st order kinetics , half-life of reactions, graphical presentation	3
Kinetics of Complex system ● Second order reactions (equal and unequal concentration), Derivation for rate constant, half life, graphical presentation ● Third order reactions (equal concentration) Derivation for rate constant, Graphical presentation ● General equation for the nth order reaction with equal initial concentration Derivation for rate constant, graphical presentation	2
Types of complex reaction Parallel, opposing and chain reactions. Elementary reactions and overall rate law, Steady state approximation, graphical presentation	1
Kinetics of Enzymes Catalysis Modes of Enzyme-Substrate interactions- Lock and Key model, induced fit model, Michaelis equation for enzyme catalysis	2

Photochemical reactions • Photochemical process . Jablonski diagram, The primary quantum yield , Quenching • Fluorescence Resonance Energy Transfer (FRET) • Effect of Temperature in photosynthesis and photochemical reduction process	2

Thermodynamics (10 lectures)	
Thermodynamics of transition • Phase Diagram of water and carbon dioxide • Phase Rule	2
Statistical thermodynamics ● Macrostate and Microstate, ● Types of ensembles ● Absolute entropy and work function, S = klnW ● Stirling's approximation ● Derivation of partition function -Translational, Rotational, vibrational ● Determination of thermodynamic quantities from partition function	8
Quantum chemistry (10 lectures)	
● Failure of Classical mechanics and need of Quantum Chemistry ● Black body radiation ● UV Catastrophe ● Heisenberg uncertainty principle ● Wave particle duality, ● Time independent Schrödinger equation of free particle & Hydrogen like atoms ● Operators- x, px, py, pz, Lx, Ly, Lz ,V, H, ● Particle in 1D/3D- Box. sketch Ψ vs r and Ψ^2 vs r for n = 0, 1, 2, 3, 4,5. ● Postulates of quantum mechanics ● Eigenfunctions, Values ● Application to electrons linear conjugated hydrocarbons Huckel theory	10

Suggested Reading:

1. Peter Atkins & Juliode Paula,"*Atkins'PhysicalChemistry*"(10 th edition).
2. Atkins & de Paula "*Physical Chemistry*" 7th-10th ed
3. Principles of Chemical kinetics J E House
4. Physical Chemistry, A molecular approach by Donald A McQuarrie, John D. Simon
5. Elements of Physical Chemistry by Atkins
6. Physical Chemistry for Chemical and Biological Sciences by Raymond Chang
7. Principles of Physical Chemistry -Samuel H Marron, Carl F Prutton ,4th edition

Course Code: CHM502 **Number of Credits**: 2

Course Name: Catalysis and Industrial Processes **Type:** Theory

NEP Vertical: Discipline Specific Course (DSC) **Number of lectures:** 30

CHM 502 - Catalysis and Industrial Processes	
Course outcomes CO1: The student should be able to understand the concepts in catalytic process CO2: The student should be able to understand the types of catalytic processes CO3: The student should be able to understand the applications of various catalytic processes	
Topic Details	**Lectures**
Fundamental aspects of catalysis (4 lectures) Homogeneous and Heterogeneous catalysis. The role of catalytic processes in modern chemical manufacturing - organometallic catalysts - catalysis in organic polymer chemistry - catalysis in petroleum industry - catalysis in environmental control.	4
Homogeneous catalysis (8 lectures) Steam reformation, natural gas (methane), reformation of hydrocarbons, Monsanto acetic acid synthesis, alkene polymerization, Carbonylation, hydrogenation, hydroformylation, hydrogenation vs hydroformylation, Monoelectronic transfer, Shell process, Wacker acetaldehyde synthesis, photoactivated catalysis and metal cluster catalysts, Asymmetric catalysis using chiral phosphoric acids, CPA (e.g. BINOL-phosphoric acid), e.g. asymmetric hydrogenation, epoxidation, hydroformylation.	8
Heterogeneous Catalyst (8 lectures) Ruhrchemie/Rhone-Poulenc Oxo process using aqueous biphasic catalysis, Zeolites, their structure and properties, natural vs synthetic zeolites, zeolytes as catalysts, mesoporous materials in heterogeneous catalysis, The flue gas depollution, Energy and CO2, Hydrogenation, Oxidation, Refining technology etc.	8

Biocatalysts: Applications and Kinetics (6 lectures) Introduction to enzymes and enzyme catalysed reactions. Classification and mechanism of reaction. Purification and characterization of enzymes. Michaelis Menten kinetics, Industrial enzymes. Applications of enzymes in diagnostics, analysis, biosensors and other industrial processes and bio-transformations. Enzyme structure determination, stability and stabilisation. Enzyme immobilization and concept of enzyme engineering. Nanobiocatalysis.	6
Photocatalysis (4 lectures) Porphyrins -phthalocyanines and semiconductors as photo catalysts in photolysis reactions - generation of hydrogen by photo catalysts - photocatalytic breakdown of water and harnessing solar energy - photocatalytic degradation of dyes - environmental applications.	4

Suggested Readings:

1. Weller et al. (IC), 6th ed, Ch 21, 22 & 25, Housecroft and Sharpe (HS), 4th ed, Ch 26, 24.2, 24.7, 25
2. Cotton, F.A. and Wilkinson, G. "Advanced Inorganic Chemistry", 4th Ed. John Wiley & Sons, New York.
3. Huheey, J.E.,Keiter, E.A. andKeiter, R.L. "Inorganic Chemistry: Principles of Structure and Reactivity",4thEd.,LowPrintEdition,Pearson Education Ltd, Asia, Reprint in India.
4. Pecoraro, V.L. "Manganese Redox Enzymes", VCH: New York.
5. Concise Inorganic Chemistry by J.D. Lee - 5th Edition.
6. Inorganic Chemistry - D.F. Shiver & P.W. Atkins- C.H. Longford ELBS 2nd Edition.
7. Basic Inorganic Chemistry - F.A. Cotton and G. Wilkinson, Wiley Eastern
8. Industrial Catalysis: A practical approach by Jens Hagen Wiley (2006)
9. Industrial Catalysis: Optimizing catalysts and processes by R. I. Wijngaarden, K. R. Westerterp, and A. Kronberg
10. Handbook of Industrial Catalysts by L. Lloyd 4. Fundamentals of Industrial Catalytic Processes by C. H. Bartholomew
11. Rothenberg, G., Catalysis: Concepts and green applications, Wiley VCH, 2008 12. Gupta, B. D, Elias, A. J., Basic Organometallic chemistry: Concepts syntheses and applications, 2nd edition, Orient Blackswan, 2013
13. Price and Stevens, Fundamentals of enzymology, Oxford University Press 2000
14. Buchholz, Kasche and Bornscheuer, Biocatalysts and Enzyme Technology, Wiley-VCH 2012
15. Polaina and MacCabe, Industrial Enzymes: Structure, Function and Applications, Springer 2007
16. B. Viswanathan, S. Kannan, R.C. Deka, Catalysts and Surfaces: Characterization Techniques, , New Delhi, 2010.
17. M. Kaneko, I. Okura, Photocatalysis: Science and Technology, Springer, 2003.

Course Code: CHM503 **Number of Credits**: 2

Course Name: Design and Synthesis of Organic Molecules **Type:** Theory

NEP Vertical: Discipline Specific Course (DSC) **Number of lectures:** 30

CHM 503 - Design and Synthesis of Organic Molecules	
Course outcomes: CO1: The student should be able to understand the structure and reactivity relationship CO2: The students should be able to understand the designing of reaction sequence for the synthesis of desired organic molecule	
Selectivity in organic synthesis Chemo-selectivity, Regioselectivity, Stereo- and enantioselectivity	2
Introduction of Pericyclic reaction ● Electrocyclic and sigmatropic reaction comparison ● Cycloaddition- Dipolar cycloaddition and retrocycloadditions, ● photochemical cycloaddition reactions, ● electrocyclic reactions ● Diels-Alder reaction	5

C-C single/ double bond formation reactions ● Mechanism of Knoevenagel, Perkin, Stobbe, Darzen, Acyloin condensations, epoxidations (Prilezhaev, Sharpless, Jacobsen), ● Metal catalyzed C-C bond formations (Heck, Suzuki, Stille reactions). ● Phosphorus, nitrogen and sulfur ylides, Wittig reaction, Wittig-Horner reaction, ● McMurry reaction, β-eliminations (Hoffman & ester pyrolysis), Cope elimination	5

Oxidation and Reduction Reactions ● Oxidations of hydrocarbons (alkanes, alkenes and aromatic), ● alkenes to epoxides (peroxides/per acids based), ● alkenes to diols (Manganese, Osmium- based), ● Sharpless asymmetric dihydroxylation, alkenes to carbonyls with bond cleavage (manganese, osmium, ruthenium and lead based-ozonolysis), ● alkenes to alcohols/carbonyls without bond cleavage (hydroboration-oxidation, chromium based allylic oxidation), ● ketones to α-hydroxy ketones, α,β-unsaturated ketones, ● Hydride reducing agents, Birch reduction, Catalytic Hydrogenation reaction, Carbonyl reduction reaction.	8
Target oriented synthesis ● Designing organic synthesis, Retrosynthetic analysis, ● disconnection approach, linear and convergent synthesis. ● Diversity-oriented synthesis: concept of forward-synthetic analysis	5
Asymmetric Synthesis ● Use of chiral auxiliaries, chiron approach. ● Principles and use of enzymes in the synthesis of industrially important sugar / fatty acid esters, sugar nucleotide derivatives	5

Suggested Reading:

1. *OrganicChemistry* by J.McMurray,7thEd.,Thomson,2008.*PrinciplesofOrganicSynthesis*byR. Norman and J.M. Coxon, 3rd Ed., Chapman and Hall, 1993
2. Carey, F. A. and Sundberg, R. J., "Advanced Organic Chemistry, Part B: Reactions and Synthesis", 5th Ed., Springer.
3. *Organic* Chemistry by J. Clayden, N. Greeves, S. Warren and P. Wothers, 2nd Ed, Oxford Press,2012
4. Clayden, J., Greeves, N. and Warren, S., "Organic Chemistry", Oxford University Press. 4. Smith, M.B., "Organic Synthesis", 3rd Ed., Academic Press.
5. Bruckner, R., "Organic Mechanisms: Reactions, Stereochemistry and Synthesis", Springer.

Course Code: CHM504 **Number of Credits**: 2

Course Name: Introduction to Analytical Chemistry **Type:** Theory

NEP Vertical: Discipline Specific Course (DSC) **Number of lectures:** 30

CHM504 Introduction to Analytical Chemistry	
Course outcomes: CO1: The student should be able to understand the various analytical techniques for the separation of compounds CO2: The students should be able to understand the selection of proper analytical techniques based on need.	
Topic Details	**Lectures**
Fundamentals of Analytical Methods Statistics and chemometrics: statistical calculations, confidence limits, tests of significance, correlation coefficient, propagation of error; sampling methods: representative samples, automation of sampling and sample treatment; experimental design; quality control and assurance, volumetric and gravimetric methods; quantitative aspects of colorimetry; theory of different types of titrations: acid-base, precipitation, redox, complexometric, nonaqueous, etc.; Introduction to analytical sensors; automated method of analysis; continuous flow methods; flow injection analysis; kinetic methods of analysis; miscellaneous methods: turbidimetry, refractometry, polarimetry, optical rotatory dispersion and circular dichroism.	5
Electroanalytical Methods Introduction, electrochemical cells, types of electrodes, classifications of electroanalytical methods. Analytical applications of two-electrode systems: conductometry and potentiometry; controlled potential techniques: constant potential (e.g., amperometry), potential step (e.g., pulse techniques), and potential sweep methods (e.g., cyclic voltammetry); electrogravimetry, electrophoresis, electrosynthesis, coulometry, flow electrolysis, thin-layer electrochemistry; electrochemical sensors; electrochemical technology.	5
Environmental Analytical Chemistry Sampling of air, water and soil for chemical analysis; monitoring techniques of air pollutants, air quality standards, pollutants standards index (PSI), monitoring of volatile organic compounds; water pollution: water quality parameters and their determination, algal blooms and algal toxins, monitoring pesticide residues in water and soil, water treatment: municipal water treatment, waste water treatment methods.	5

ANALYTICAL BIOCHEMISTRY **Body Fluids** Composition of body fluids and detection of abnormal levels of certain constituents leading to diagnosis of disease., Physiological and nutritional significance of water and fat soluble vitamins and minerals. Analysis for constituents of physiological fluids, viz., urine, blood, serum. Analytical techniques for vitamins including microbiological techniques.	3
IMMUNOLOGICAL METHODS General processes of immune response, Antigen-antibody reactions, precipitation reactions, radio, enzyme, and fluoro-immuno assays. Human nutrition : Biological values and estimation of enzymes, carbohydrates, essential amino acids, proteins, and lipids	2
SPECTRAL METHODS Infra-red spectroscopy, NMR, Mass spectroscopy, Raman spectroscopy, Isotope dilution method and activation analysis, radiometric and radio-release methods Auto, X-ray and gamma radiography, Principle, Instrumentation and applications of: Differential Thermal Analysis, Differential Scanning Calorimetry, Thermometric titrations, Evolved gas analysis, HYPHENATED TECHNIQUES : Need for hyphenation, Interfacing devices and applications of GC - MS, GC - IR, MS-MS, HPLC - MS, ICP -MS, ICP - OES.	10

Suggested Readings:

1. D.A.Skoog, D.M.West, F.J.Holler and S.R.Crouch, Fundamentals of Analytical Chemistry 9E, 9th Ed., Brooks/Cole, 2014
2. D.A.Skoog, F.J.Holler and T.A.Nieman, Principles of Instrumental Analysis, 5th Ed., Thomson,1998. 8. Analytical Chemistry, G. D. Christian, 4th Ed. John Wiley, New York (1986)
3. Fundamentals of Analytical Chemistry, D .A. Skoog and D. M. West and F. J. Holler Holt- Saunders (1992)
4. Principles of Instrumental Analysis, D. A. Skoog, F. J. Holler and J.A. Niemann, 5th Edition (1998)
5. Instrumental methods of Analysis, H. H. Willard, L. L. Merritt, Jr. J. A.Dean 6th Ed CBS (1986)
6. Instrumental methods of Analysis, H. H. Willard, L. L. Merritt Jr, J. A. Dean 7th Ed CBS (1986)
7. Introduction to instrumental analysis, R. D. Braun, Mc Graw Hill (1987)
8. General, organic and biological chemistry, H. Stephen Stoker, Cengage Learning.
9. Advance dairy chemistry, vol 3, P. F. Fox, P. L. H. McSweeney Springer.
10. Physiological fluid dynamics vol 3, Nanjanagud Venkatanarayanasastry Chandrasekhara Swamy Narosa 1992
11. Molecular Biological and Immunological Techniques and Applications for food, edited by Bert Popping, Carmen Diaz-Amigo, Katrin Hoenicke, John Wiley & sons.
12. Analytical Chemistry, G. D. Christian, 4 th Ed. John Wiley, New York (1986)
13. Fundamentals of Analytical Chemistry, D. A. Skoog and D. M. West and F. J .Holler Holt- Saunders 6th Edition (1992)
14. Principles of Instrumental Analysis, D. A. Skoog, F. J. Holler and J.A. Niemann 5th Edition (1998)
15. Instrumental methods of Analysis, H. H. Willard, L. L. Merritt, Jr J. A. Dean and F. A. Settle Jr 6th Ed CBS (1986)

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Course Code: CHM505 **Number of Credits**: 2

Course Name: Physical & Analytical Chemistry- LAB-1 **Type:** Practical

NEP Vertical: Discipline Specific Course (DSC) **Number of lectures:** 60

(2 credits , 1 session per week)

CO1: The student should be able to correlate the theoretical concepts to while performing the experiment

CO2: The student should be able to understand the applications of the instruments used in each experiment

List of experiments (Any 10)

1. Determination of order of reaction between potassium persulphate and potassium iodide
2. To study the effect of concentration on the rate of reaction of hydrolysis of methyl acetate.
3. To determine the energy of activation for the acid catalysed hydrolysis of methyl acetate.
4. To study the kinetics of oxidation of alcohol using potassium dichromate by spectrophotometer.
5. To study the kinetics of saponification reaction by conductometric method.
6. Study of kinetics by potentiometry.
7. To study the phase diagram of a binary system (Phenol + water)
8. To study the effect of salt on critical temp on the phase diagram of a binary system (Phenol + KCl solution)
9. Determination of Na, K in a soil sample by flame photometry.
10. Use of fluorescence to do “presumptive tests” to identify blood or other body fluids.
11. Estimation of saponification of oil value.
12. Estimation of Calcium from milk powder.

OR any other suitable experiment can be added or replaced.

V-Lab experiments for self study

13. Determination of glucose from food sample by glucose oxidase method.
14. Other related V-lab experiments

Course Code: CHM506 **Number of Credits**: 2

Course Name: Inorganic & Organic Chemistry- LAB-1 **Type:** Practical

NEP Vertical: Discipline Specific Course (DSC) **Number of lectures:** 60

CO1: The student should be able to correlate the theoretical concepts to while performing the experiment

CO2: The student should be able to learn the synthesis and analytical techniques in each experiment

List of the experiments (Any 10)

1. Hippuric acid from Glycine (Benzoylation)
2. Glucosamine derivatives from glucose
3. Estimation of glycine
4. Knoevenagel condensation between aldehyde (4-diethylaminobenzaldehyde) and malonic acid, cyanoacetic acid or malononitrile.
5. Asymmetric reduction of EAA by using Bakers yeast.
6. SBH reduction
7. Separation of organic compounds using column chromatography.
8. Separation of binary mixture of cations by Column Chromatography (3 mixtures) (One mixture should be colorless, Zn + Al, Zn + Mg)
9. Estimation of nickel as Ni – DMG using gravimetry
10. DEgradation of hydrogen peroxide using Fe as a catalyst (Fenton Reaction)
11. Estimation Iron by thiocyanate method by colorimetry.
12. Synthesis of trans -diaqua -bis glycinato nickel (II) complex

OR any other suitable experiment can be added or replaced.

V-Lab experiments for self study

1. Jablonski diagram
2. Any other related V lab experiment

Course Code: CHM507 **Number of Credits**: 2

Course Name: Green Chemistry **Type:** Theory

NEP Vertical: Discipline Specific Elective (DSE) **Number of lectures:** 30

Course Outcomes: At the end of the course students will be able to

CO1: Apply the principles of green chemistry to reduce the pollution in chemical processes.

CO2: Develop economical synthetic route involving principles of green chemistry.

Topic Details	Lectures
Introduction to Green Chemistry (10 L) What is Green Chemistry? Need for Green Chemistry. Goals of Green Chemistry. Problems in the applications of the goals of Green Chemistry. The 12 Principles of Green chemistry: application of principles, examples based on 12 principles. Environmentally benign solutions: Organic solvents and volatile organic compounds, solvent free systems, supercritical fluid, supercritical carbon dioxide and supercritical water. Replacing smog producing and ozone depleting solvents with CO_2 for precision cleaning and dry cleaning of garments.	10
Green Reactions over Traditional synthesis (12 lectures) Green Synthesis of the Compounds: Adipic Acid and Ibuprofen Microwave assisted reactions: Oxidation of alcohols; Diels-Alder reaction in Organic Solvent (Atom economy) and Water (Green Solvent and Atom economy). Ultrasound assisted reactions: Simmon-Smith Reaction Enzymatic Inter esterification for production of no Trans-Fats and Oils. Vitamin C synthesis –enzyme routes Polythene manufacture-metallocene catalysis Surfactants for carbon dioxide.	12
Applications of Green Chemistry (08 L) Renewable raw materials, Reagents and catalysts; multifunctional reagents; Combinatorial green chemistry; Click Chemistry, Solventless reactions; Solid Phase synthesis, Applications of Green chemistry in Sustainable Development	8

Suggested Readings:

1. Green Chemistry - Theory and Practical by P.T. Anastas and J.K. Warner, Oxford University Press (1998).
2. Introduction to Green Chemistry by A.S. Matlack, Marcel Dekker (2001).
3. Real-World cases in Green Chemistry by M.C. Cann and M.E. Connely, American Chemical Society, Washington (2000).
4. Introduction to Green Chemistry by M.A. Ryan and M. Tinnes, American Chemical Society, Washington (2002).
5. Green Chemistry: An Introductory Text by M. Lancaster, RSC Publishing, 2nd Edition, 2010.

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Course Code: CHM508 **Number of Credits**: 2

Course Name: Green Chemistry Practical **Type:** Practical

NEP Vertical: Discipline Specific Elective (DSE) **Number of lectures:** 60

1 session per week

List of the experiment

1. Nitration of phenols using calcium nitrate.
2. Bromination of acetamide using ferric ammonium nitrate and KBr in aqueous solution.
3. Solvent free microwave assisted pot synthesis of phthalocyanine Cu(II) complex.
4. Green synthesis of nanoparticles using leaf extract. (Any2) E.g. copper, silver, chromium
5. Extraction of natural dyes. (any 2) Eg. IndigoIndigo dye, dye from any natural resource
6. PhotodegradationPhotodegradation of dye (Any 2) e.g. Methyl orange, Azo dye,

OR
Any other relevant experiment can be added or replaced

Course Code: CHM509 **Number of Credits**: 2

Course Name: Introduction to Forensic Science & Technology **Type:** Theory

NEP Vertical: Vocational Skill Course (VSC) **Number of lectures:** 30

Introduction to Forensic Science & Technology	
Course Outcomes **CO1**: The student should be able to understand the legal aspects of Forensic Science **CO2**: The student should be able to apply the analytical techniques as per the need	
History and development of Forensic Science Historical aspects of forensic science, Definitions and concepts of forensic science, Need of Forensic Science, Basic Principles of Forensic Science, Scope of development of forensic science. Functions of Forensic Science, Different branches of Forensic Science. Frye case and Daubert standard. Scope and development of forensic science.	5
Legal aspects of crime: Crime – Introduction Natures, causes and consequences of crime, Broad concepts of criminal Justice system, Procedures involved in the detection of crime, Filing of criminal charges, Indian police system – The Police Act, Human rights and criminal justice system in India. Set up of INTERPOL. Duties and qualification of forensic science.	2
Organizational set up of Forensic Science Laboratory (FSL) in India Hierarchical set up of central forensic science laboratory, Hierarchical set up state forensic science laboratory, Government examiners of questioned documents. Chemical examiners laboratory, Fingerprint bureaus, National crime records bureau, Bureau of police research and development, Mobile crime laboratory, Duties of forensic scientist, code of conduct of forensic scientists. Drug enforcement administrator. Defense research and development organization.	3
Forensic Chemistry : Analysis of Chemicals from the samples **Petroleum and Petroleum Products**: Distillation and fractionation of petroleum. Commercial uses of different petroleum fractions. Analysis of petroleum products. Analysis of traces of petroleum products in forensic exhibits. Comparison of petroleum products. Adulteration of petroleum products. **Cases Involving Arson**: Chemistry of fire. Conditions for fire. Fire scene patterns. Location of point of ignition. Recognition of type of fire. Searching the fire scene. Collection and preservation of arson evidence. Analysis of fire debris. Analysis of	12

ignitable liquid residue. Post-flashover burning. Scientific investigation and evaluation of clue materials. Information from smoke staining. **Explosives: Classification of explosives** – low explosives and high explosives. Homemade explosives. Military explosives. Blasting agents. Synthesis and characteristics of TNT, PETN and RDX. Explosion process. Blast waves. Bomb scene management. Searching the scene of the explosion. Mechanism of explosion. Post blast residue collection and analysis. Blast injuries. Detection of hidden explosives	
Forensic Biology Nature and importance of biological evidence. Significance of hair evidence. Transfer, persistence and recovery of hair evidence. Structure of human hair. Comparison of hair samples. Morphology and biochemistry of human hair. Comparison of human and animal hair. Types and identification of microbial organisms of forensic significance. Identification of wood, leaves, pollens and juices as botanical evidence. Diatoms and their forensic significance	6

Suggested readings:

1. B.B. Nanda and R.K. Tiwari, Forensic Science in India: A Vision for the Twenty First Century, Select Publishers, New Delhi (2001).

2. M.K.BhasinandS.Nath,Role of Forensic Science The New Millennium,University of Delhi, Delhi(2002). 3. S.H. James and J.J. Nordby, Forensic Science: An Introduction to Scientific and Investigative Techniques, 2nd Edition, CRC Press, Boca Raton (2005)

4. 4.W.J. Tilstone, M.L. Hastrup and C. Hald, Fisher's Techniques of Crime Scene Investigation, CRC Press, Boca Raton (2013).

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Course Code: BIO501 Number of Credits: 2

Course Name: Biomolecules: Structure & Significance **Type:** Theory

NEP Vertical: Minor **Number of lectures:** 30

Biomolecules: Structure & Significance	
Course outcomes **CO1:** The students should be able to understand the biomolecules present in various parts of cell **CO2:** The student should be able to understand the structure and significance of biomolecules	
Topic Details	**Lectures**
Chemistry of Cell Types of cell :- prokaryotic and eukaryotic Cell organelles and their functions. Molecules that constitute the organization of cell and its organelles. Chemical bonding in organelles	2
Carbohydrates Introduction, classification of carbohydrates, their structures and biological significance. Concept of anomers, epimers, reducing and non-reducing sugars, mutarotation, inversion. Reactions of glucose with acid, base, phenyl hydrazine, oxidizing agents, reducing agents and its significance, Glycosidic bonds.	5
Lipids Introduction, classification of lipids, their structures and biological significance. Reactions of Lipids-Saponification Hydrolysis, emulsification, oxidation. Concept of saponification number, acid number, iodine number and their significance. Rancidity. Types of Lipoproteins and their significance. Blood group substances	5
Proteins **Classification of Proteins** Classification based on function, nutrition and composition. Structural organization of proteins- primary, secondary, tertiary and quaternary structures. **Amino acids** Amino acids: classification of amino acids. Concept of ampholytes, isoelectric pH, zwitter ions, titration curve of glycine. Reactions of amino acid with Ninhydrin, Sanger's, Dansyl chloride, Dabsyl chloride and Edmann's reagents and their significance. Peptide bond and its features.	15

Enzymes Classification of enzymes. Factors affecting enzyme activity. Modes of ES interaction. Types of Enzyme inhibitions- Competitive, noncompititive and uncompitivie. Concept of Conjugated enzymes Holoenzyme, Apoenzyme, prosthetic groups. Coenzymes of vitamins. Industrial applications of enzymes.	
Hormones Introduction to endocrine glands and their hormones. Biochemical nature of hormones, Mechanism of action of lipophilic and hydrophilic hormones	3

References

1. Lehninger's Principles of Biochemistry, by Nelson and Cox Macmillan Publisher 4 th Edn. 2. Biochemistry by U. Satyanarayana
3. Harper's Illustrated Biochemistry, 26th Edition
4. Biophysical techniques by Upadhyay and Nath, 3rd revised edition.
5. Organic Chemistry, Morrison, R. T. & Boyd, R. N. 6. Organic Chemistry (Volume 1) Finar, I. L.
7. Organic Chemistry (Volume 2) Finar, I. L
8. Organic Reaction Mechanism Peter Sykes

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Course Code: IDC501 **Number of Credits**: 2

Course Name: Project/Field Project **Type:** Practical

NEP Vertical: Field Project (FP) **Number of lectures:** 60

Implementation a**s per the circular of Government of Maharashtra and the Savitribai Phule Pune University**

Course outcome:

CO1: The student should be able to think and work independently.

CO2: the student should develop an interdisciplinary approach

It offers an opportunity to the students to work independently under guidance of a supervisor.

Students will be assigned to the on campus faculty/ research scientists from various national research institutes under whose guidance the student would work on a problem by visiting the places i.e field visits.

The supportive laboratory work keeps the focus to enhance their own ability to their critical thinking, identification of research problems, doing related referencing and formulation of research plan.

This would train the students to get the experience of the field work and team work. It nurtures their soft skills, leadership quality and creativity.

Adequate assessment requirements for individual marking are presentations with discussions on the overall satisfactory completion of the work.

T.Y.B.Sc.Blended Chemistry

SEMESTER VI

Course Code: CHM601 **Number of Credits**: 2

Course Name: Solid State Chemistry & Nanoscience **Type:** Theory

NEP Vertical: Discipline Specific Course (DSC) **Number of lectures:** 30

CHM 601 - Solid State Chemistry & Nanoscience	
CO1: The student should be able to identify various crystal types and analyse structures CO2: the student should be able to identify the nanoparticles and its applications.	
Solid State Chemistry (15 lectures)	
Fundamentals Types of solids - close packing of atoms and ions - bcc, fcc and hcp voids –Gold schmidt radius ratio - derivation - its influence on structures - structures of rock salt - cesium chloride - wurtzite - zinc blende - rutile - fluorite - antifluorite - diamond and graphite-spinel - normal and inverse spinels and perovskite - lattice energy of ionic crystals -Madelung constant - Born-Haber cycle and its applications.	5
Theories Band theory of solids. Superconductivity: Occurrence, BCS theory, high temperature superconductors. Free electron Theory, zone theory, MO theory of Solids Dislocation in solids: Schottky and Frenkel defects. Line defects and plane defects – nonstoichiometric compounds. Electrical properties: Energy bands, insulators, semiconductors and conductors-superconductors- dielectric superconductors, dielectric properties, piezoelectricity, ferro electricity- conductivity in pure metals.	5
X- Ray diffraction Theory- the crystal systems and Bravais lattices - Miller indices and labelling of planes Symmetry properties - crystallographic point groups and space groups - X-ray diffraction - powder and rotating crystal methods - systematic absences and determination of lattice types - Analysis of X-ray data for cubic system Structure factor and Fourier synthesis -Fundamentals of electron and neutron diffraction.	5

Nanoscience (15 lectures)	
Introduction to nanomaterials ● Introduction; fundamentals of nanomaterials science, surface science for nanomaterials, Size controls properties (optical, electronic and magnetic properties of materials) ● Applications (carbon nanotubes and nanoporous zeolites; Quantum Dots, basic ideas of nanodevices)	2
Synthesis of nanoparticles ● The advent of nanomaterials. Top down and bottom up approaches to building materials. ● Physical and Chemical methods of nanoparticle synthesis ● Ball milling, Inert gas condensation, arc discharge, RF plasma, plasma arc technique, ion sputtering, laser ablation, laser pyrolysis, ball milling, molecular beam epitaxy, ● Chemical vapour deposition method and electro deposition., Redox reactions,	4
The basic tools of analysis of nanoparticles ● Scanning electron microscopy (SEM), Transmission Electron Microscopy (TEM) ● Energy Dispersive X-ray Analysis (EDAX) and X-ray diffraction, ● A brief historical overview of Atomic Force Microscopy (AFM) and an introduction to its basic principles & applications. ● Optical microscopy and their description, operational principle and application for analysis of nanomaterials, ● UV-Vis-IR spectrophotometers, Principle of operation and application for band gap measurement.	5
Metal nanoparticles ● Size control of metal nanoparticles and their characterization, study of their properties, optical, electronic, magnetic. ● Surface plasmon band and its applications, role in catalysis, alloy nanoparticles, stabilization in sol, glass, and other media, change of bandgap, blueshift, colour change in sol, glass, and composites, Plasmon resonance	2
Carbon nanostructures ● Introduction. Fullerenes, C60, C80 and C240 nanostructures. Properties & applications (mechanical, optical and electrical). Functionalization of carbon nanotubes, reactivity of carbon nanotubes. ● Nano-sensors: Temperature sensors, smoke sensors, sensors for aerospace and defence. Accelerometer, pressure sensor, night vision system, nano tweezers, nano-cutting tools, integration of sensors with actuators and electronic circuitry biosensors	2

Suggested Reading:

1. Physical Chemistry by P.W. Atkins 8th Edition
2. Introduction to Physical Chemistry by Marron and Prutton
3. Solid State Chemistry and it's Applications by West/ Nanoscale materials in Chemistry by Klabunde
4. T. Pradeep, Nano: The Essentials, Tata McGraw-Hill, New Delhi, 2007.
5. G. Cao, Nanostructures and Nanomaterials – Synthesis, Properties and Applications, Imperial College Press, London, 2004, chapters 3, 4 and 5.
6. C. N. R.Rao, A. Muller and A. K. Cheetham, The Chemistry of Nanomaterials, Volume Wiley –VCH Verlag GmbH & Co. KgaA, Weinheim, 2004, Chapter 4.
7. Nanoparticles- Theory and Applications by Schmid
8. Carbon Nanomaterials by Challa
9. Nanomaterials- Synthesis, properties and applications by Rao CNR, Miller A, Cheetham AK. 7.
10. Carbon Nanotubes- Basic Concepts and Physical Properties by Reich S, Thomsen C, Maultzsch

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Course Code: CHM602 **Number of Credits**: 2

Course Name: Bioinorganic and Coordination Chemistry **Type:** Theory

NEP Vertical: Discipline Specific Course (DSC) **Number of lectures:** 30

CHM 602 - Bioinorganic and Coordination Chemistry	
CO1: Understanding of various metal - ligands in biological system CO2: Understanding the significance of coordination compounds	
Bioinorganic Chemistry (10 lectures)	
Topic Details	**Lectures**
Metals and ligands in Biological system • Amino acid side chains, specialized ligands, • Porphyrins, enterobactin in biological systems • Availability of Fe, Cu and Zn • Uptake of Fe, gut, • trans-ferrin and ferritin - Structure and properties • Oxygen transport in human body with geometrical changes in haemoglobin • Zn as a source of nucleophilic –OH, • Need of Cu and its toxic nature • Photosynthesis-chlorophyll reaction center and oxygen evolving center. • Overview of significance of bioinorganic compounds in biological processes	10
Coordination Chemistry (20 lectures)	

Theories of Coordination Compounds ● Valence Bond Theory (VBT) - Postulates, types of hybridisation and geometry of molecules. ● Crystal Field Theory (CFT) - splitting of d orbitals in ligand fields and different symmetries ● Crystal Field Stabilisation Energy (CFSE) - Factors affecting the magnitude of 10 Dq – evidence for crystal field stabilization, spectrochemical series, site selection in spinels, tetragonal distortion from octahedral symmetry, Jahn-Teller distortion, Nephelauxetic effect. ● Molecular Orbital Theory (MOT) - Bonding in octahedral, tetrahedral and square planar complexes, experimental evidence for bonding.	4

Reactions of Coordination Complexes ● Substitution reactions in square planar complexes - The rate law for nucleophilic substitution in a square planar complex, the trans effect, theories of trans effect, mechanism of nucleophilic substitution in square planar complexes. ● Kinetics of octahedral substitution - Ligand field effects and reaction rates, mechanism of substitution in octahedral complexes. ● Reaction rates influenced by acid and bases, racemization and isomerization mechanisms of redox reactions. Outer sphere mechanisms - excited state outer sphere electron transfer reactions - inner sphere mechanisms - mixed valent complexes.	4

Structure of Coordination compounds ● Structure of coordination compounds with reference to the existence of various coordination numbers (2, 3, 4, 5 & 6). ● Site preferences , isomerism , trigonal prism , absolute configuration of complexes. ● Stereo selectivity and conformation of chelate rings for coordination number seven and eight. ● Spectral and magnetic properties of lanthanide and actinide complexes.	4
Electronic spectra and Magnetism of Coordination compounds ● Microstates, terms and energy levels for d1 – d9 ions in cubic and square fields, Selection rules , band intensities and band widths. ● Orgel and Tanabe-Sugano diagrams , evaluation of 10 Dq and β for octahedral complexes of cobalt and nickel , charge transfer spectra ● Magnetic properties of coordination compounds , change in magnetic properties of complexes in terms of spin orbit coupling , Temperature independent paramagnetism - spin crossover phenomena.	3
IR and Raman spectra of Coordination Compounds Applications of IR and Raman spectroscopy in structure determination of Coordination compounds. ● Effect of coordination on ligand vibrations ● Uses of group vibrations in the structural elucidation of metal complexes of urea, thiourea, cyanide, thiocyanate, nitrate, sulphate. ● DMSO - effect of isotopic substitution on the vibrational spectra of molecules	3
EPR of Coordination compounds ● Theory and instrumentation, spin Hamiltonian, isotropic and anisotropic EPR spectra, magic pentagon rule. ● Applications of EPR spectroscopy for the structure determination of coordination complexes and metalloproteins (Fe and Cu).	2

Suggested Reading:

1. J. E. Huheey, E. A. Keiter and R. L. Keiter, Inorganic Chemistry, Principles of Structure and Reactivity, 4thEdition, Harper Collin College Publishers, 1993.
2. F.A. Cotton and G.Wilkinson, Advanced Inorganic Chemistry, 4th& 5thEdns, Wiley Interscience, New York, 1998.
3. R.S. Drago, Physical Methods in Inorganic Chemistry, 3rd Edition, Wiley Eastern, 1992.
4. J. Lewis, R.G. Wilkins, Modern Coordination Chemistry, Inter Science Publisher, 1960.
5. D. F. Shriver, P. W. Atkins and C. H. Langford, Inorganic Chemistry, Oxford University Press, Oxford, l994.
6. K. Nakamoto, Infrared and Raman Spectra of Inorganic and Coordination Compounds, Part A &Part B, 2ndEdn, Wiley. 2009.
7. G. L. Miessler, D. A. Tarr, Inorganic Chemistry, 3rd Edn, Pearson Prentice Hall, 2005
8. J.E. House, Inorganic Chemistry, Elsevier, 2008.
9. Housecroft and Sharpe, 3rd ed, Chap 29; Weller et al, 6th ed, Chap 26.
10. Cotton, F.A., Wilkinson, G., Murillo, C.A. and Bochmann, M., "Advanced Inorganic Chemistry", 6th Ed., John Wiley & Sons
11. Douglas, B.E., McDaniel,D.H. and Alexander, J.J., "Concepts and Models in Inorganic Chemistry", 3rd Ed., John Wiley & Sons
12. Figgis, B.N., and Hitchman, M.A "Ligand Field Theory and Its Applications", Wiley Eastern Ltd
13. Huheey, J.E., Keiter, E.A. and Keiter, R.L., "Inorganic Chemistry Principle of Structure and Reactivity", 4th Ed, Pearson Education, Inc.

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Course Code: CHM603 **Number of Credits**: 2

Course Name: Natural Product and Heterocyclic Chemistry **Type:** Theory

NEP Vertical: Discipline Specific Course (DSC) **Number of lectures:** 30

Natural Product & Heterocyclic Chemistry	
CO1: Understanding the concept of natural product and their properties CO2: Understanding the concept of heterocyclic copounds and their significance	
Natural Products (15 lectures)	
Classification of natural products Chemical structure, classification, Structure elucidation based on degradative reactions Isolation and structural elucidation of selected alkaloids and terpenes- quinine, morphine, and reserpine, citral, juvabione and logiofolene Insect pheromones.	5
Amino Acids, Peptides and Proteins Classification of Amino Acids, Zwitterion structure and significance of Isoelectric point. Synthesis of amino acids Amino Acids and their Metabolites in Nature –Structure of proteins- Peptides.	3
Steroids Classification- Synthesis and structure elucidation of cholesterol, Conversion of cholesterol to progesterone- androsterone and testosterone-cortisone. Vitamin D - structure and significance. Nucleic Acids- structure of nucleosides and nucleotides-RNA and DNA, Watsons and Crick model DNA-drug interaction.	4

Carbohydrates Classification of carbohydrates, reducing and non-reducing sugars, General properties of glucose and fructose, their open chain structure. Epimers, muta-rotation and anomers. Determination of configuration- Hudsons rules-Structure of sugars transformation of sugars, Preparation of alditols, glycosides, deoxysugars. Synthesis of vitamin C from glucose.	3
Heterocyclic Chemistry (15 lectures)	
Heterocycles Synthesis, Properties and uses of Five membered heterocyclic ring systems with one or two hetero atoms-Furan, pyrrole, thiophene and thiazole: Six membered heterocyclic ring system-Pyridine. Fused heterocyclic ring systems- Indole, quinoline. Biologically important heterocycles: Pyrimidines and purines.	8
New materials derived from heterocycles Syntheses of cyanines and related dyes. Organic sensitizers for Dye Sensitised Solar Cells (DSSC)-Electron donors and acceptors for organic solar cells. Optical senators, chemo sensors and organic semiconductors for thin-film transistors.	7

Suggested Reading:

1. I. L. Finar, Organic Chemistry Vol. I & Vol. II- Pearson Education, 6th edition
2. F. A. Carey and R. J. Sundberg, (Eds) 3rd Edition, Part B. Plenum/Rosetta, 1990.
3. I. Fleming, Selected Organic Synthesis, John Wiley and sons, 1982.
4. Atta-ur-Rahman, Studies in Natural Products Chemistry, Vol.1 and 2, Elsevier, 1988.
5. R. Krishnaswamy, Chemistry of Natural Products; A Unified Approach, Universities Press.
6. R. J. Simmonds: Chemistry of Biomolecules: An Introduction, RSC.
7. Designing Organic Synthesis by Stuart Warren1983.
8. Organic Chemistry by Cram andHammond.
9. Organic Chemistry by Clayden, Greeves, Warren andWothers

Course Code: CHM604 **Number of Credits**: 2

Course Name: Advanced Analytical Techniques **Type:** Theory

NEP Vertical: Discipline Specific Course (DSC) **Number of lectures:** 30

Advanced Analytical Techniques	
Topic	**Lectures**
Extraction Techniques Partition law and its limitations, distribution ratio, separation factor, factors influencing extraction, multiple extractions. Extraction of metal. Technique of extraction: batch, continuous and counter current extractions. Qualitative and quantitative aspects of solvent extraction: extraction of metal ions from aqueous solution, extraction of organic species from the aqueous and non- aqueous media.	4
Chromatography Theory of column chromatography, retention time, retention volume, capacity factor, concept of plate and rate theory, resolution, column performance, Classification of chromatography- normal and reverse phase chromatography, paper and thin layer chromatography, ion-exchangers.	4
Gas Chromatography Principle of GSC and GLC, Separation mechanism involved in GSC and GLC, Instrumentation and working of Gas chromatography, Analysis of Chromatogram - qualitative –quantitative Application of Gas chromatography	4

High Performance Liquid Chromatography (HPLC) Principle, Separation mechanism involved in adsorption and partition HPLC, Instrumentation and working of HPLC, Applications of HPLC, Introduction to supercritical fluid chromatography.	4
Mass spectrometry Principle , working and applications	4
GCMS/LCMS Principle, instrumentation and applications	3
Data Analysis Quantitative chemical analysis; calculation of analytical results (calibration curve method, standard addition method, internal standards method) Significant figures: confidence and interval; Student's T-test; F-test; Q-test	3
Sensor Introduction, Classifications of sensors, Sensitivity and Limit of detection, Types of Sensors- Optical, Electrochemical & Biosensor. Application of Sensor in environmental and biological samples.	4

Suggested Readings

1. Textbook of Quantitative Chemical Analysis- 3rd Edition, A. I.Vogel
2. Principles of Physical Chemistry 4th edition – Prutton andMarron
3. Instrumental Methods of Chemical Analysis- Chatwal andAnand
4. Basic Concept of Analytical Chemistry-2nd edition S.M.Khopkar
5. Vogel's textbook of Quantitative Inorganic Analysis-4th edition Besset Denney, Jaffrey,Mendham
6. Instrumental Methods of Chemical Analysis- 6th edition Willard, Merritt, Dean andSettle 7.

Analytical Chemistry bySkoog

8. Introduction to Instrumental Analysis- R.D. Braun
9. Instrumental methods of Chemical Analysis-Willard, Dean & Merrit- 6th Edition

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Course Code: CHM605 **Number of Credits**: 2

Course Name: Physical & Analytical Chemistry-LAB-2 **Type:** Practical

NEP Vertical: Discipline Specific Course (DSC) **Number of lectures:** 60

Credit 2 , 1 session per week

CO1: The student should be able to correlate the theoretical concepts to while performing the experiment
CO2: The student should be able to understand the applications of the instruments used in each experiment

List of the experiments (Any 10)

1. Preparation and characterization of MgO nanoparticles.
2. Preparation and characterization of ZnO nanoparticles.
3. Preparation and characterization of Graphene Oxide.
4. Green synthesis of Silver nanoparticles using extract of leaves.
5. Analysis of a given crystal data.
6. Analysis of given HPLC data.
7. Determination of molecular weight by viscometry.
8. Determination of molecular weight using steam distillation.
9. Determination of composition of a complex using potentiometry.
10. Study of redox reactions of Fe2+/Fe3+ using potentiometry
11. Determination of Iron by Atomic Absorption Spectrometry
12. Halide estimation

OR any other relevant experiment can be added or replaced.

Virtual Laboratory for self study

Determination of Caffeine in Soft Drinks by High Performance Liquid Chromatography.
Environmental Monitoring of Hydrocarbons: A Chemical Sensor Perspective.

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Course Code: CHM606 **Number of Credits**: 2

Course Name: Inorganic & Organic Chemistry- LAB-2 **Type:** Practical

NEP Vertical: Discipline Specific Course (DSC) **Number of lectures:** 60

Credit 2, 1 session per week

CO1: The student should be able to correlate the theoretical concepts to while performing the experiment

CO2: The student should be able to understand the techniques used in each experiment

List of the experiments (Any 10)

1) Determination of Metal to ligand ratio in a given complex by Job's Method.

   eg. Fe(III) and salicylic acid

2) Synthesis and spectral analysis of metal complexes and find their 10 Dq value.
3) Determination of formula of cuprammonium (II) ion.
4) Solvent free microwave assisted one pot synthesis of phthalocyanine copper (II) complex.
5) Synthesis of Coordination compounds (Any2)
6) Fisher indole synthesis
7) Synthesis of Natural product (Any 1)
8) Extraction of natural products (Any1)
   Lycopene from tomato peels, Cinnamic acid from cinnamon from, Trimsin from nutmeg

9) Synthesis of heterocycles using Diels Alder reaction.
10) Synthesis of furan from 1,3-butadienes.
11) Synthesis of amide derivatives of carboxylic acid.
12) Synthesis of p- dichlorobenzene and p-chlorobenzyl alcohol from chlorobenzene.

OR any other relevant experiment can be added or replaced.

Course Code: CHM607 **Number of Credits**: 2

Course Name: Agricultural Chemistry **Type:** Theory

NEP Vertical: Discipline Specific Elective (DSE) **Number of lectures:** 30

CO1: Know the various branches of agricultural Chemistry and thirst areas of research
CO2: Understand the role of chemistry in Agriculture
CO3:Understand various method of soil analysis for crop selection

Topic details	Lectures
Introduction to Agricultural chemistry (5 Lectures) Soil and Water Management, Composition, water pollution and soil pollution. Branches of Agricultural Chemistry Agricultural Production, Food Processing, Pesticides, Insecticides, Herbicides, Fungicides, Processing of raw products into foods and beverages, Chemurgy, Environment Restoration. Major research areas in Agricultural chemistry such as improvement and restoration of soil fertility, Use and Recycling of biomass, Biostimulants for Agriculture, Economic and policy studies related to production of agricultural raw materials (Food & Nonfood),Tracking impurities, Environmental,human and animal safety. Management of Rural areas and environmental resources.	5
Role of Chemistry in Agricultural Science (10 Lectures) Photosynthesis: Basics of Photosynthesis, Fertilizers: Classification, Natural and artificial fertilizers. Examples for natural fertilizers, Artificial fertilizers: Nitrogenous, Phosphatic, Potash fertilizers. Pesticides and Insecticides: Classification (Based on use and chemical composition), Chemistry, composition and processing of agricultural Insecticides & Pesticides. Benefits of Pesticides, Potential hazards of Pesticides. Pesticides-Safety measures. Insect Repellents: Examples. Chemistry in Other areas: For improved irrigation, Storage and preservation of Agricultural products, Food processing, Chemicals from agricultural waste.	10

Soil Chemistry (5 Lectures) Introduction to soil chemistry, definitions of soil, Soil components- Mineral component, organic matter or humus, soil atmosphere, soil water, soil microorganism. Physical properties of soil- Soil texture, soil structure, soil colour, soil temperature, soil density, porosity of soil. Surface soil and sub-soil, Functions of soil. Chemical properties of soil - Soil reactions, importance of soil reaction, factors controlling soil reactions,	**5**
Soil Analysis (10 Lectures) Objectives of soil testing. Collection of soil Samples from field., Soil sample preparation for analysis of various parameters Digestion and Extraction Procedures for soil. Different methods of soil fertility evaluation. Determination of the following parameters of soil pH , EC and TDS , organic matter, available nitrogen, available phosphorus, calcium and magnesium from soil by EDTA method, sodium and potassium by flame photometry method, carbonate and bicarbonates, Calculation of the RSC, SAR, SSP, Salinity of soil. Interpretation of soil data - Soil health card Comment on the problematic soils : Acidic soils- formation of acid soil, effect of soil acidity on plant, reclamation of acidic soil, application of lime in improving the acidity of soil, lime requirements. Alkaline Soil- formation of alkali soil, reclamation of alkali soil. Classification of alkali soil- saline soil, alkali soil, saline alkali soil, non-saline alkali soil.	**10**

Suggested Readings

1. A text book of soil science (Revise Edition) J. A. Daji. Revised by J. R. Kadam, N. D. Patil, Media promoters and publishers, Mumbai, 1996.
2. Text book of soil science, T. D. Biswas, S. K. Mukherjee, 2nd ed. Tata McGraw Hill Publishing company, New Delhi, 2017.
3. Introduction to Agronomy and soil, water management, V. G. Vaidya, K. R. Sahashtrabuddhe, (Continental Prakashan).
4. Principals of soil science, M. M. Rai, 4th ed. Million complex of India, Bombay, 1977.
5. Manures and fertilizers (12th ed.), K. S. Yawalkar, J. P. Agarwal and Bokde, Agrihorticulture

publishing house, Nagpur, 2016.
6. Chemistry of insecticides and fungicides, U.S. Sreeramula (2nd ed.), oxford and IBH Publishing company, New Delhi.
7. Fundamentals of soil sciences, Henry D. Foth, 8th ed. John Wiley and Sons, 1990. Book Soft copy URL: https://1lib.in/book/634160/343570
8. Soil, Plant, Water and fertilizer analysis, P. K. Gupta, 2nd ed. Agrobios Publication, Jodhpur, India. Book Soft copy URL: https://content.kopykitab.com/ebooks/2016/06/7111/sample/sample_7111.pdf
9. Handbook of Biofertilizers and biopesticides, A. M. Deshmukh, R. M. Khobragade and P. D. Dixit, Oxford Book Company, Jaipur, India 2007. Book Soft copy URL: https://1lib.in/book/961124/8ecdcd
10. Essential Plant Nutrients uptake use efficiency and Management, M. Naeem, Abid A. Ansari, Sarvajeet Singh Gill Editor, Springer International Publishing AG, 2017. Book Soft copy URL: https://1lib.in/book/3376008/16ba17
11. The Use of Nutrients in crop plants, N.K. Fageria, CRC Press, Taylor and Francis Group, LLC, 2009. Book Soft copy URL: https://1lib.in/book/550595/3a2232
12. Agronomic Handbook – Management of crops, soils and their fertility, J. Benton Jones, Jr. CRC Press LLC, Washington D.C. 2003. Book Soft copy URL: https://1lib.in/book/946311/37a879
13. The chemistry of Organophosphorus Pesticide, Christa Fest, Karl-Julius Schmidt, 2nd revised ed., Springer, Verlag Berlin Heidelberg, New York, 1982
Book Soft copy URL: https://1lib.in/book/2137868/423f0a

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Course Code: CHM608 **Number of Credits**: 2

Course Name: Agrochemical Practical **Type:** Practical

NEP Vertical: Discipline Specific Elective (DSE) **Number of lectures:** 60

1 session per week

List of the experiments

1. Analysis of Phosphate from fertiliser
2. Analysis of copper from fungicide.
3. Method of collection of soil samples (Field work).
4. Determination of physical properties of soil.
5. Determination of pH of soil.
6. Determination of organic matter in the soil.
7. Determination of available nitrogen in the soil.
8. Determination of EC and TDS of soil.
9. Isolation of azotobacter from soil.
10. Development of azotobacter fertiliser.
11. Making of soil health card

OR any other related experiment can be added or replaced.

Suggested Readings:

1. Chukwuebuka Egbuna, Jonathan Chinenye Ifemeje, Shashank Kumar, Stanley Chidi Udedi, 2019, Phytochemistry, Volume 1: Fundamentals, Modern Techniques, and Applications. Apple Academic Press/Taylor & Francis
2. Hans- Walter Heldt and Fiona Heldt, 2005. Plant Biochemistry (3rd Edition). Elesevier, New Delhi - 024
3. S. C. Santra. 2015. Practical Botany: Vol. 2. New Central Book Agency, Kolkata 700 009
4. AVSS Samba murty and N S Subrahmanyam. A Textbook of Economic Botany. Wiley Eastern Limited, Pune.
5. Plant Biochemistry (2012) Florence K. Gleason & Raymond Chollet. University of Nebraska, Lincoln, Jones & Bartlett Learning.
6. D. Mitra, J Guha and S. K. Chowdhuri. Studies in Botany: Vol - 2. Moulik Library, Calcutta - 700073
7. S. Sadasivam and A. Manickam. 1996. Biochemical Methods. New Age International Publication.

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Course Code: CHM609 **Number of Credits**: 2

Course Name: Materials Chemistry **Type:** Theory

NEP Vertical: Vocational Skill Course (VSC) **Number of lectures:** 30

Materials Chemistry	
Course outcomes **CO1: The students should be able to understand the types of materials and their applications based on their properties**	
Topic Details	**Lectures**
Basics of crystalline solids Crystalline solids, crystal systems, Bravais lattices, coordination number, packing factors – cubic, hexagonal, diamond structures, lattice planes, Miller indices, interplanar distances, directions, types of bonding , lattice energy, Madelung constants, Born Haber cycle, cohesiveenergy,Symmetryelements,operations,translationalsymmetriespointgroups,spacegr oups,equivalent positions, close packed structures, voids, crystal structures, Pauling rules, defects in crystals, polymorphism,twinning.	10
Silica based materials Introduction to Zeolites, metallic silicates, silicalites and related microporous materials, Mesoporous silica, metal oxides and related functionalized mesoporous materials: Covalent organic frameworks, Organic-Inorganic hybrid materials, periodic mesoporous organo silica, metal organic frameworks: H2 /CO2 gas storage and catalytic applications	10
Composite materials Introduction, limitations of conventional engineering materials, role of matrix in composites, classification, matrix materials, reinforcements, metal-matrix composites, polymer-matrix composites, fibre-reinforced composites, environmental effects on composites, applications of composites.	10

Suggested readings:

- Atkins P, Overton T., Rourke J. Weller M. and Armstrong F Shriver and Atkins. Inorganic Chemistry Oxford University Press, Fifth Edition,2012.
- Adam, D.M. Inorganic Solids: An introduction to concepts in solid-state structural chemistry. JohnWiley,1974.
- Poole, C.P. & Owens, F.J. Introduction to Nanotechnology John Wiley2003. • Rodger, G.E. Inorganic and Solid State Chemistry, Cengage Learning,

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Course Code: IDC601 **Number of Credits**: 4
Course Name: Project/On Job Training **Type:** Practical
NEP Vertical: On Job Training (OJT) **Number of lectures:** 60

Implementation will be as per the circulars of Government of Maharashtra and Savitribai Phule Pune University

CO1: The student should be able to develop the interdisciplinary approach
CO2: The student should be able to get the experience of working in their area of specialization.

It offers an opportunity to the students to work independently under guidance of a supervisor at the workplace.
This would train the students to work in the area of their specialization.

The students are expected to submit a report and laboratory book.
Adequate assessment requirements for individual marking are presentations with discussions and seminars on the working process and the results.

Internships

The students are expected to complete the additional 4 credits for internship within the 3 years.

National Skills Qualifications Framework (NSQF) internship details are available at the website https://www.nielit.gov.in/content/nsqf

Summer training/internships will be encouraged to work as summer trainees or interns in other institutes/ laboratories/ industries depending upon the scope and availability during summer/winter recess. After the period of training, it is expected that students achieve the following:

- Recognize the duties, responsibilities and ethics at a professional position.
- Ability to apply knowledge learned to solve specific problems in relevant domains of science.
- Gain exposure and practical experience in the relevant field.
- Ability to prepare technical reports for the training.
- Ability to communicate effectively in the work environment.
