



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

S. Y. B. Sc. Blended (Semester III & IV)

Major: Chemistry

Minor: Biology

Syllabus and Course structure

Choice Based Credit System (CBCS)

NEP-Version II

from

Academic Year 2025-26

Credit Framework

Semester 3	S.Y.B.Sc.Blended Semester III (NEP Version II)			
Course Code	Course Name	Credits	NEP Vertical	Type of course
24BLCH23101	Chemistry: Reactions and Synthesis	2	DSC	Theory
24BLCH23102	Chemistry Practical-3	2	DSC	Practical
24BLPH23101	Quantum Mechanics and Thermodynamics	2	DSC	Theory
24BLPH23402	Physics Practical-3	2	VSC	Practical
24BLBI23201	Functional Biology of Organisms	2	Minor	Theory
24BLBI23202	Biology Practical-3	2	Minor	Practical
24BLMT23301	Vector Calculus & Differential Equations	2	GE/OE	Theory
24BLIKS23401	Indian Knowledge System from Major subject (Generic)	2	IKS	Theory (T/P)
24BLMA23501	From Common Basket- Indian Language	2	AEC	Theory
24BLFP23601	Field Project	2	FP	Practical
24BLCC23601	From Common Basket- Yoga/NCC/NSS/Red Cross etc	2	CC	Practical
	Total credits	22		

Semester 4

Semester 4	S.Y.B.Sc.Blended Semester IV (NEP Version II)			
Course Code	Course Name	Credits	NEP Vertical	Type of course
24BLCH24101	Chemistry: Structure and Properties	2	DSC	Theory
24BLCH24102	Chemistry Practical-4	2	DSC	Practical
24BLPH24101	Electricity, Magnetism, Special Relativity, and Optics	2	DSC	Theory
24BLPH24402	Physics Practical-4	2	VSC	Practical
24BLBI24101	Genetics, Evolution and Ecology	2	Minor	Theory
24BLBI24102	Biology Practical-4	2	Minor	Practical
24BLMT24301	Probability	2	GE/OE	Theory
24BLMT24502	Statistics	2	SEC	Theory (T/P)
24BLMA24501	From Common Basket- Indian Language	2	AEC	Theory
24BLCEP24601	Community Engagement and Services	2	CEP	Practical
24BLCC24601	From Common Basket- Yoga/NCC/NSS/Red Cross etc.	2	CC	Practical
	Total credits	22		

Detailed Syllabus from the next page

SEMESTER III**Course Code:** 24BLCH23101**Number of Credits:** 2**Course Name:** Chemistry: Reactions and Synthesis**Type:** Theory**NEP Vertical:** Discipline Specific Course (DSC)**Number of lectures:** 30

Chemistry: Reactions & Synthesis	
Credits : 2	Number of lectures: 30
Topic	No. of Lectures
Reactions and Synthesis 1 (10 lectures)	
Organic Synthesis C-C bond Forming Reactions: Grignard Reagents and Organolithiums. Formation and reaction with Carbonyl compounds. Organometallic Reagents in Synthesis: Applications of Organocerium and Organocuprate reagents.	1
Carbonyl Compounds and Reactions: Carbonyl compounds, tautomerism as a general phenomenon, keto-enol tautomerism of carbonyl compounds, mechanism of keto-enol tautomerism Generating enolate anions, suitable base catalysts for enolising aldehydes, ketones ester and β -dicarbonyl compounds, general α substitution reaction	1
Reactions of enols and enolates, α -substitution with H/D^+ Stereochemical consequences and deuterium incorporation. Halogenation of carbonyl compounds, The haloform reaction	1
Halogenation of carbonyls, Hell-Volhard-Zelinsky reaction. Synthetic applications of α -halo carbonyl compounds	1
Alkylation of enolates, LDA, scope and limitations	1
Aldol reaction, mechanism and retrosynthesis, inter-and- intra molecular variants, mixed Aldol reaction	1
Claisen reaction, mechanism and retrosynthesis, mixed Claisen and Dieckman reaction.	1

Malonate Diester Chemistry, Acetoacetate chemistry, Synthesis of substituted acetic acid and acetone derivatives. Scope, Mechanism and Retrosynthesis.	1
Michael addition Chemistry, reaction of enolates with various Michael electrophiles	1
Kinetic and Thermodynamic enolates, Enamines and silylenol ethers	1

Reactions and Synthesis 2 (10 lectures)	No. of Lectures
Redox (and important acid-base) Reactions: Oxidation of elements by halogens and dioxygen. Metal and main group halides and oxides. Discussion of selected syntheses, chemistry and structures of halides and oxides including amphoteric behaviour and hydroxide/aqua ion formation. Thermodynamic vs kinetic control of reactions.	1
Thermodynamic aspects of halide and oxide formation. Thermodynamic parameters, their estimation and uses of tabulations. Born-Haber cycle and construction and uses of Ellingham diagrams for these systems. (Electrides and sodides?)	1
Oxidation of metals by protons etc. and generation of aqua ions. Comparison of TM and main group systems and hydrolysis in TM aqua ions (acid-base chemistry of coordinated water-hydroxide-oxo ligands). Connection between electrochemical and thermodynamic parameters. Construction and uses of Latimer and Frost diagrams.	1
Interpretations of Frost diagrams exemplified by the more complex chemistry of main group elements, such as nitrogen. Thermodynamic content of plots (free energy of formation vs oxidation state) and predictive power.	1
Nernst equation revisited and construction and uses of Pourbaix diagrams combining redox and acid base reactions. Comparison of chemistry of representative elements as reflected in Pourbaix diagrams.	1

Exchange reactions: Solid/gas phase systems exemplified by transport reactions and preparation of solid-state materials, in vulcanology, halogen lamps etc. Solution examples of double decomposition (metathesis). Solubility trends. Common ion effect.	1
Hard/soft acid/base theory. Thermodynamic basis for HSAB theory. Usefulness in predicting direction of equilibrium and solubility.	1

Substitution Reactions: Typical reactions and synthetic applications and examples. Inert and labile complexes. Stability (K , b) and factors affecting stability (metals, ligands). Irving-Williams series, Chelate effect. Applications of chelate effect. Siderophores. antioxidants, garden products, chelation therapy in medicine.	1
Mechanism of substitution reactions. Square planar Pt complexes and applications. Trans effect. Pt chemistry. Applications in synthesis of action of chemotherapeutic agents. Dissociative, interchange and associative mechanisms in substitution, racemization <i>etc</i> in octahedral complexes.	1
Combination of substitution and redox chemistry in TM systems. Co(III) syntheses, Cr(II) catalysed substitution. Electron transfer, inner and outer-sphere reactions. Metal centred reactions: Template reactions and reactions of coordinated ligands. Atom transfer reactions (redox reactions). Metal directed ligand syntheses	1
Thermodynamics (10 lectures)	
Ideal gases, the kinetic theory of gases, equipartition theory, Boltzmann distribution	1
Heat, work, internal energy. First law of thermodynamics. Heat capacity and enthalpy. Compression of an ideal gas under various conditions. Latent heats	1
Multiplicity and ideal gases. Entropy, spontaneous change and the Second Law of Thermodynamics. Interacting ideal gases and the entropy of mixing.	2

Gibbs Free energy and spontaneity, Helmholtz Free energy, standard free energies, free energy as a function of pressure and temperature The Fundamental equation, properties of internal energy and Maxwell's relations	2
Thermodynamics criteria for chemical and phase equilibria, chemical potential and partial molar quantities, the Gibbs Free Energy minimum and equilibrium, extent of reaction and equilibrium constant, molecular description of equilibrium, response of equilibria to temperature	2
Thermodynamics of liquids and liquid mixtures, chemical potentials of liquids, ideal liquid mixtures and Raoult's Law, Henry's Law, vapor pressure diagrams, liquid-liquid phase diagrams Free energy and entropy of mixing, excess functions and real solutions, solute and solvent activity, activity coefficient, osmotic pressure	2
Total	30

Suggested Readings

1. Peter Atkins & Juliode Paula, "*Atkins' Physical Chemistry*" (10th edition). Chapters 16 & 20
 2. Atkins & de Paula "*Physical Chemistry*" 7th-10th ed
 2. Inorganic Chemistry- J.D.Lee
 3. *Organic Chemistry* by J. McMurray, 7th Ed., Thomson, 2008. *Principles of Organic Synthesis* by R. Norman and J.M. Coxon, 3rd Ed., Chapman and Hall, 1993
 4. Carey, F. A. and Sundberg, R. J., "Advanced Organic Chemistry, Part B: Reactions and Synthesis", 5th Ed., Springer.
 5. *Organic Chemistry* by J. Clayden, N. Greeves, S. Warren and P. Wothers, 2nd Ed, Oxford Press, 2012
 6. Clayden, J., Greeves, N. and Warren, S., "Organic Chemistry", Oxford University Press.
 4. Smith, M.B., "Organic Synthesis", 3rd Ed., Academic Press.
 7. Bruckner, R., "Organic Mechanisms: Reactions, Stereochemistry and Synthesis", Springer.
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Course Code: 24BLCH23102

Number of Credits: 2

Course Name: Chemistry Practical-3

Type: Practical

NEP Vertical: Discipline Specific Course (DSC)

Number of lectures: 60

1 session per week

List of the experiments

- 1) Determination of EMF of a given cell and determination of its thermodynamic parameters (free energy and equilibrium constant)
- 2) Determination of time of flow and comment on the trend in the viscosity of the given liquid.
OR Determination of molecular weight of a polymer using viscometer.
- 3) Measurement of pH of soil samples and suggestions about the remedy in soil health (if any) and the suitable crops to be taken.
- 4) Determination of pH of given water samples, suggestions to make it drinkable (if any).
- 5) Determination of molecular weight using steam distillation.
- 6) Benzyldehyde to benzyl acetophone
- 7) Hydroquinone to quinone
- 8) Separation of binary mixtures (Any three)
(i) Acid-Base, (ii) Acid-Neutral, (iii) Base-Neutral, (iv) Base-Phenol, (v) Phenol-Neutral

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Course Code: 24BLPH23101

Number of Credits: 2

Course Name: Quantum Mechanics and Thermodynamics

Type: Theory

NEP Vertical: Discipline Specific Course (DSC)

Number of lectures: 30

Quantum Mechanics and Thermodynamics	
Credits : 2	Number of lectures: 30
Topic	Lectures
Quantum Mechanics (15 lectures)	
The Breakdown of Classical Physics	1
Matter Waves and Quantum Interpretation	2
Quantum Mechanics in One Dimension	2
Expectation Values, Observables and Operators	2
Tunneling Phenomena	2
Quantum Mechanics in 3-dimensions	2
Hydrogen atom, hydrogenic ions, helium atom	2
Hydrogen molecule ion, hydrogen molecule	2
Thermodynamics (8 lectures)	
Temperature and the Zeroth Law of Thermodynamics. Thermal equilibrium.	2
Transport, conduction, conductivity, diffusion in gases.	1
The two-state paramagnet and the Einstein model of a solid; quantum deviations from classical equipartition. Partition function. Interacting systems, large systems, Stirling's approximation	2
Heat engines, Carnot Cycle, Otto Cycle, Stirling Cycle.	3
Applications of PDEs in thermodynamics (2 lectures)	
Wave equation	1
Heat and Diffusion equation	1
Application Linear Algebra in quantum mechanics (5 lectures)	

Change of basis and linear transformations	1
Definition of eigenvectors and eigenvalues	1
Calculating eigenvalues and eigenvectors	1
Diagonalisation of matrices; matrix powers	1
Orthogonal matrices, real symmetric matrices	1
Total	30

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Course Code: 24BLPH23402

Number of Credits: 2

Course Name: Physics Practical-3

Type: Practical

NEP Vertical: Vocational Skill Course Course (VSC) **Number of lectures:** 60

1 session per week

List of the experiments

- 1) Michealson's interferometer: To find the wavelength of given laser beam.
- 2) Specific charge of the electron (e/m): To find the specific charge of the electron from the path of an electron beam in crossed electric and magnetic fields of variable strength.
- 3) Rydberg's constant: To find Rydberg's constant using diffraction grating.
- 4) Photoelectric effect: To estimate Planck's constant and work function of the photoelectrons by measuring the variation of stopping potential with the frequency of light. To see the graph of current Vs voltage for different intensity and frequency of light.
- 5) Electron diffraction: To measure diameter of smallest diffraction rings at different anode voltages.
- 6) Millikans oil drop experiment: To measure the charge of the electron.

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Course Code: 24BLBI23205

Number of Credits: 2

Course Name: Functional Biology of Organisms

Type: Theory

NEP Vertical: Minor

Number of lectures: 30

Functional Biology of Organisms	
Credits : 2	Number of lectures: 30
Topic	No. of Lectures
Functional Biology of Organisms	
Introduction to Functional Biology	1
Animal biology (Humans as an example)	
Anatomy and Function 1: Tissues, Organs and Viscera	1
Anatomy and Function 2: Skeletal & Muscular system	1
Nervous system 1: The central nervous system (CNS) and nervous tissues	1
Nervous system 2: Autonomic nervous system and motor responses	1
Endocrine system 1: Endocrine and Exocrine glands	1
Endocrine system 2: HPA axis introduction	1
Respiration and Metabolism 1: Breathing in air and water	1
Respiration and Metabolism 2: Regulation of metabolism	1
Cardiovascular and circulatory system 1: Regulation of the circulatory system Cardiovascular and circulatory system 2: Peripheral circulation	1
Digestive system	1
Urinary and Excretion systems 1: Anatomy and function	1
Urinary and Excretion systems 2: Osmoregulation in terrestrial & aquatic environments	1
Thermal dynamics	1

Immunology 1: Innate immune system Immunology 2: Adaptive/Humoral immune system	1
Reproduction and Development 1: Gonads and the Reproductive tract	1
Reproduction and Development 2: Gametes, Fertilization and conception	1
Plant biology	
Growth and Development	1
Photosynthesis	2
Water Balance	2
Phloem and translocation	1
Mineral nutrition and nutrient assimilation	1

Respiration and lipid metabolism	1
Reproduction	1
Signaling; hormones, light responses, control of flowering	1
Abiotic stress	1
Secondary metabolism and defense	1
Microbial physiology	1

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Course Code: 24BLBI23206

Number of Credits: 2

Course Name: Biology Practical-3

Type: Practical

NEP Vertical: Minor

Number of lectures: 60

1 session per week

List of the experiments

- 1) Preparation of media, autoclaving and culturing of bacteria using different plating techniques, dilution and colony counting
- 2) Bacterial Growth curve
- 3) Grams staining (gram positive, gram negative and yoghurt samples)
- 4) Enzyme kinetics (effect of pH, temperature, substrate and enzyme concentration)
- 5) Estimation of glucose
- 6) Antibiotic sensitivity test: zone of inhibition

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Course Code: 24BLMT23307

Number of Credits: 2

Course Name: Vector Calculus and Differential Equations

Type: Theory

NEP Vertical: Generic Elective/Open Elective (GE/OE) **Number of lectures:** 30

MTH 301 Vector Calculus and Differential Equations	
Topic	Lectur es
Linear Algebra (10 lectures)	
Characteristic and minimal polynomial, Cayley-Hamilton Theorem	1
Applications of eigenvectors/diagonalisation eg Markov chains	1
Inner product axioms; examples/non-examples of inner products	1
Length, angle, Cauchy-Schwarz inequality in terms of inner product	1
Orthogonality, projections in terms of inner product	1
Change of basis and linear transformations	1
Definition of eigenvectors and eigenvalues	1
Calculating eigenvalues and eigenvectors	1
Diagonalisation of matrices; matrix powers , Orthogonal matrices, real symmetric matrices	1
Gram-Schmidt algorithm	1
Vector Calculus (10 lectures)	
Functions of several variables; level curves and cross sections of surfaces	1
Common surfaces including paraboloid, ellipsoid, hyperboloid	
Domains and ranges of functions of several variables	1
Limits and continuity of functions of several variables; Definition of C^N	
Partial derivatives, tangent plane	1
Differentiability of functions of several variables	1
Directional derivative, gradient	
Chain rule and total derivative	1

Stationary points of surfaces, classification of stationary points using second derivatives	1
Optimisation applications	
Constrained extrema using Lagrange multiplier method	1
Double integrals, changing order of integration	
Polar co-ordinates, change of variables for double integrals	
Triple integrals	1
Change of variables for triple integrals; cylindrical co-ordinates	
Spherical co-ordinates	
Vector fields, div and curl operators	
Parameterisation of paths	
Line integrals of scalar & vector functions ,	1
Integrals of scalar functions over surfaces, applications of surface integrals eg surface area, mass	
Integrals of vector functions over surfaces, flux	
Green's Theorem	1
Gauss Divergence Theorem	
Stokes' Theorem	
Applications of integral theorems eg Maxwell's equations	
Polynomial Differential Equations (PDEs) (10 lectures)	
Fourier Series	2
Fourier series: Dirichlet, discontinuities and differentiation	2
Fourier series: Weak convergence and series summation	1
Linearity and Superposition	1
Laplace equation and harmonic functions	2
Fourier transform : Properties and applications	2

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Course Code: 24BLFP236011

Number of Credits: 2

Course Name: Field Project

Type: Practical

NEP Vertical: Field Project (FP)

Number of lectures: 60

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

Course outcome:

CO1: The student should be able to get the experience of collecting samples from various places.

CO2: the student should be able to analyse the collected samples/ data.

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 for doing related referencing and analyses the data or samples.

This would train the students to get the experience of the field work and team work. It nurtures their soft skills and interdisciplinary approach.

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

SEMESTER IV**Course Code:** 24BLCH24101**Number of Credits:** 2**Course Name:** Chemistry: Structure and Properties**Type:** Theory**NEP Vertical:** Discipline Specific Course (DSC)**Number of lectures:** 30

Chemistry: Structure and Properties	
Credits :2	Number of lectures: 30
Structure and Properties	No. of Lectures
Molecular shape and simple electronic structure, Isomerism: Orbitals, hybridization and shapes of molecules, stereochemical consequences of tetrahedral carbon (isomers, enantiomers, R/S, D/L, optical rotation)	1
Stereochemistry – optical activity: Molecules with more than one chiral centre (diastereomers, meso compounds, separation of racemic mixtures)	1
Symmetry operations and elements	1
Group theory: Definition of reducible and irreducible representations, Use of group theory to determine the irreducible representation	1
Assignment of point groups	1
Leading to definition of components of character tables (irreducible representations, characters – at least the interpretation of the sign of the character)	
Simple applications, Label molecular shapes, isomers, Identify chiral molecules, Physical properties – <i>e.g.</i> dipole moment, possible optical isomers, Orbital symmetry labels (<i>e.g.</i> s, p & d orbitals in T _d , O _h , D _{4h})	1
Stereochemistry and Reactions: Prochirality, chirality in Nature, Stereochemistry on atoms other than carbon, Retrosynthetic analysis Stereochemistry and Mechanism (nucleophilic substitution, elimination from non-cyclic compounds)	1

Alkene addition reactions – Hydrogenation, halogenation, HX addition. Elimination Reactions epoxide ring forming reactions	1
Zeeman effect: Effect on the energies of a system by application of a magnetic field; Magnetochemistry, spin and orbital contribution to the magnetic moment	1
Magnetic resonance spectroscopies: EPR spectroscopy, hyperfine coupling application to organic radicals and to transition metal complexes	1
Nuclear Magnetic Resonance (NMR), energies of nuclei in magnetic fields Chemical shift and the δ scale, resonance of different nuclei, shielding, spin-orbit coupling and coupling constants, molecular symmetry	1
^{13}C NMR, ^1H NMR, integration, multiplicity, chemical shift typical ranges	1
Introduction to molecular spectroscopy and spectroscopic transitions, absorbance, transmittance, the Beer-Lambert Law, intensities of spectroscopic transitions	1
Quantised vibration and simply harmonic oscillator model, wave functions, Molecular vibrational modes, vibrational spectroscopy infrared and Raman spectroscopy $3N-5$, $3N-6$ vibrational degrees of freedom	1
Vibrational symmetry and IR/Raman activity: Symmetry properties of the vibrational degrees of freedom and to deduce IR, Raman activity. Use of internal coordinates to get symmetry properties of a subset of bands. Vibrational spectroscopy: Local mode approximation. Characteristic infrared absorptions (alkyl CH, alcohol, amine RNH_2 and R_2NH , carboxylic acid, amide, ester, ketone, aldehyde, nitrile RCN , alkyne, alkene, aromatic), fingerprint regions, interpretation of IR spectra	1
Molecular orbital theory: Electronic spectroscopy requires understanding of electronic structure leading to Molecular orbital theory – HOMO. LUMO, Diatomic molecules, LCAO-MO, Symmetry of MO's, Generalisation of the application of MO approaches to polyatomic molecules	1
Photoelectron spectroscopy	1
Hückel Theory	1
Aromatic and Heterocyclic Chemistry of compounds with delocalised p	2

orbitals: Benzene and Aromaticity/Antiaromaticity, Reactions of Aromatic Compounds Electrophilic aromatic substitution. Reactions of Polycyclic and Heteroaromatic Compounds. Reactions via Aromatic Transition States Electrophilic aromatic substitution on naphthalene. Electrophilic aromatic substitution on heteroaromatics (<i>e.g.</i> pyridine and pyrrol). Non C-based aromatic systems	
Electronic spectroscopy: Chromophores and excited electronic states, electronic transitions, UV-Vis spectroscopy, Franck-Condon Principle, Franck-Condon factors	1
Fates of electronic excited states – fluorescence and phosphorescence, non radiative transitions, internal conversion and intersystem crossing, fluorescence spectra	1
Applications – light emitting polymers	1
Organometallic chemistry. Types and broad applications of organometallic complexes and catalysts. Ligand types and examples.	1
Group 1 (LiR) and group 2 (Grignard) and p-block chemistries. EPR spectroscopy as a tool to probe electron distribution in carbocyclic and organometallic species	1
Covalent interactions in coordination compounds – rationalisation of spectrochemical series in terms of bonding interactions	1
Binary metal carbonyl complexes Synergistic bonding and the 18-electron rule. IR and NMR spectroscopy	1
Substitution at metal carbonyl. Other organometallic ligand types and complexes thereof. Alkyne and alkene complexes. <i>etc.</i>	1
Redox reaction in organometallic chemistry. Hydrogen complexes and oxidative addition reactions. Reductive elimination reactions. Activation and reactions of organometallic ligands. Insertions, migrations.	1
Catalysis involving transition metals : Catalytic systems. Water gas shift reaction, hydrogenations, acetic acid process <i>etc.</i> Metallocene complexes and their chemistry leading to advanced polymerization catalysts <i>etc.</i>	1
Total	30

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Course Code: 24BLCH24102

Number of Credits: 2

Course Name: Chemistry Practical-4

Type: Practical

NEP Vertical: Discipline Specific Course (DSC)

Number of lectures: 60

1 session per week

List of the experiments

I] Analysis by Instrumentation Method (Any 3)

- 1) Verification of Beer-Lambert's law using a colorimeter/spectrophotometer. (Compulsory)
- 2) Estimation of Cu by photometric titration with EDTA.
- 3) Hydrolysis constant of aniline hydrochloride using pH metry.
- 4) Dissociation constant of an acid- base indicator by spectrophotometry.
- 5) Photometric determination of stability constant of the complex. e.g. Fe(III)salicylicylate
- 6) Estimation of iron from a given drug sample.
- 7) Potentiometric determination of stability constant of silver ammonia complex
- 8) Any other experiment as per the need.

II] Preparation and Spectral Analysis of Inorganic Complexes (Any 2)

- 1) Potassium trioxalato chromate (III).
- 2) Tris (acetylacetonato) Iron (III).
- 3) Bis (ethylene diamine) copper (II) sulphate.

III] Synthesis by Green Approach (Any 1)

- 1) Acetanilide synthesis
- 2) Esterification
- 3) Microwave reaction

IV] Double Stage Synthesis, Purification and Analysis (Any 2)

- 1) Glycine – Hydantoic acid – Hydantoin
- 2) Benzoin – Benzil - Benzilic acid
- 3) Acetanilide – p-Bromoacetanilide – p-Bromoaniline
- 4) Acetanilide – p-Nitroacetanilide – p-nitro aniline.
- 5) Hydroquinone – Quinoline – 1,2,4 – Triacetoxybenzene.
- 6) Napthalene – Nirtonapthelene – p-amino benzoic acid

V] Interpretation of UV, FT-IR & ¹H-NMR spectrum of above synthesized compounds.

- 1) U.V. spectroscopy: Calculation of $\lambda_{\max}$ of the compounds.
- 2) Combined problems on U.V., I.R. and NMR Aliphatic Compounds
- 3) Combined problems on U.V., I.R. and NMR Aromatic Compounds
- 4) Fluorescence Spectroscopy

VI] Use of Computers for literature search- Scifinder, Reaxys and other search engines.

VII] Instrument introduction, theory and applications: IR, Mass, NMR, GC, HPLC & XRD

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Course Code: 24BLPH24103 **Number of Credits:** 2 **Type:** Theory

Course Name: Electricity, Magnetism, Special Relativity and Optics

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

Electricity, Magnetism, Special Reactivity and Optics	
Credits :2	Number of lectures: 30
Topic	No. of Lectures
Electricity and Magnetism (15 lectures)	
Coulomb's Law	1
Gauss's Law	1
Electric Field, Potential	1
Conductors, Insulators	2
Laplace equation	2
Curl and Stoke's theorem	2
Capacitors, capacitance and energy stored in E field	1
Current and continuity equation	1
Magnetic field and Moving Charges	1
Force on Moving charges	1
Magnetic Field and vector potential	1
Special relativity and E and B fields	1
Induction	1
Inductance and energy stored in B field	1
RC circuits	1
CL and RLC circuits	1
Displacement current	1
Complete Maxwell's Equations	1

Electromagnetic Waves	1
Dielectrics and Electric Dipoles	1
Dielectrics	1
Magnetic Dipoles	1
Magnetism in Matter	1
Special relativity (15 lectures)	
Space-time and simultaneity. Einstein axioms for special relativity. The Lorentz transformation.	1
Relativistic kinematics; length contraction, time dilation. Doppler effect. Twin paradox.	1
Relativistic dynamics. Mass-energy equivalence. Conservation of four momentum. Centre of momentum frame. De Broglie waves and photons.	1
Nuclear reactions and thermonuclear power.	1
Classical optics: Fermat's Principle	1
Fourier Optics: Huygens-Fresnel Principle	1
Fourier Optics: Fresnel diffraction integral	1
Fourier Optics: Paraxial approximation	1
Fourier Optics: Fraunhofer diffraction	1
Fourier Optics: Apertures and imaging	1
Fourier Optics: phase contrast imaging	1
Microscopy applications	4
Total	30

Course Code: 24BLPH24402

Number of Credits: 2

Course Name: Physics Practical-4

Type: Practical

NEP Vertical: Vocational Skill Course (VSC)

Number of lectures: 60

1 session per week

List of the practicals

1. Verification of Stefan's Law by Electrical method and Study the temperature dependence of total radiation and hence verify the Stefan's Law.
2. Determine of the wavelength of sodium light by measuring the diameters of Newton's rings and Determine of the Reflection Index of a Liquid transparent medium such as water using Newton's ring apparatus.
3. Measurement of wavelength of Laser by Diffraction Grating.
4. Measurement of Resistivity & Band gap of Germanium Crystal(N-type) by Four Probe Method.
5. To determine the coefficient of Linear Expansion of a given Sample. 6. Study of LR circuit.

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Course Code: 24BLBI24201

Number of Credits: 2

Course Name: Genetics, Evolution and Ecology

Type: Theory

NEP Vertical: Minor

Number of lectures: 30

Genetics, Evolution and Ecology	
Credits :2	Number of lectures: 30
Transmission Genetics	No. of Lectures
Genetic variation and behaviour of genes	1
Linkage and recombination; Mapping genes	2
Chromosome maps and genetic markers	1
Sex linkage and sex determination	1
Complementation	1
Chromosomal mutations	1
Non-Mendelian inheritance	1
Extrachromosomal DNA	2
Quantitative genetics	2
Population Genetics	
Genetic variation in populations	1
Mutation and Genetic drift	1
Natural selection	1
Mutation/Selection balance	1
Balanced polymorphism	1
Gene flow & inbreeding	1
Population Biology	
Nature of populations; numbers, mixing (dispersal), structure in age/stage	1
Density independent, density dependent growth (exponential and logistic growth equations)	1

R & K selection, life-histories and links to population growth parameters, (annual vs perennial life-histories, clonality)	1
Demography, Life tables, matrix models (requires simple matrix mathematics) and Epidemiology (simple functions)	1
Communities	
Nature of communities; Community structure: how it is described, measured; what drives it; species composition, diversity (alpha, beta, gamma)	1
Intra-community (interspecific) interactions (bi-partite networks); Symbiosis, Predation, Competition, Host-parasite interactions	1
Dynamics of communities (perturbation and succession)	1
Biomes (communities on a global scale)	1
Ecosystems	
Pond ecosystem (or other integrated example)	1
Food chains and webs	1
Pyramids (numbers, biomass, energy), abstraction, defining trophic levels, the problem of omnivory (stable isotope tracers)	1
Biogeochemical cycles (water, C, N, P) pools and fluxes, mass budget models. Rates of processes: productivity, decomposition, trophic transfer, turnover and Mean Residence Time.	1
Total	30

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Course Code: 24BLBI24202

Number of Credits: 2

Course Name: Biology Practical-4

Type: Practical

NEP Vertical: Minor

Number of lectures: 60

1 session per week

List of the experiments

1. Study of the pond ecosystem: physical, chemical factors; biota; primary productivity estimation; role as carbon sink; community structure (over time)
 2. Visit the pond, collect samples in three seasons – monsoon (already collected in July/Aug), post-monsoon (January) and summer (March). (field visits)
 - i) measure physico-chemical parameters, depth, turbidity, DO, primary productivity (field+lab sessions)
 - ii). identify vegetation types, succession in vegetation
 3. Introductory population dynamics (Daily monitoring required)
 4. i. Establish a simple culture of cladoceran species (isolated from pond sample) in lab. Study dynamics of population (growth curves).
 - ii. Density dependant growth – same culture, initiate the experiment with different starting densities.
 - iii. Create an artificial mesocosm (tub/tank of defined area), and inoculate with Lemna. / Azolla sp. (brought from nearby habitats). Monitor growth, density and biomass over time.
 5. Introduction to Habitat & Community ecology
 - i. Visit different types of water bodies (one river/stream and one quarry/pond/lake) and conduct
 6. iSampling. Study habitat ecology and community composition. (field session)
 - ii. Identify, quantify zooplankton taxa in collected samples. Calculate diversity indices. (lab session)
 - iii. Introduction to various sampling methods (point count/line transect/quadrat) in field.
 7. Learn methods for estimating plant biomass (using GBH). (field session)
 8. Potential sites for field visits: Tamhini Ghat/ Devkund waterfall (major field trip; one day long) + Pashan lake/MIT quarry (short field trip, 1-2 hrs.)
 9. Functional ecology (**Optional**)
 - i. Using established plankton cultures perform grazing experiments using range of food densities. (Lab session).
 10. Population genetics: solving problems
 - i. Use of ABO blood group data to calculate allele frequencies. Data can be gathered both by interviews and by actual blood group determination).
 - ii. use of PTC (phenylthiocarbamide) tasting trait to calculate allele frequencies.
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Course Code: 24BLMT24301

Number of Credits: 2

Course Name: Probability

Type: Theory

NEP Vertical: Generic Elective/Open Elective (GE/OE) **Number of lectures:** 30

Probability	
Credits : 2	Number of lectures: 30
Probability (30 lectures)	No. of Lectures
Review of probability, events, laws of probability	2
Conditional probability, independent events	2
Random variables; discrete random variables and distributions; mean, variance and standard deviation of discrete random variable	2
Bernoulli trials, binomial distribution	2
Poisson distribution and Poisson process	1
Continuous random variables and distributions, probability density functions, cumulative distribution function	1
Mean, variance, standard deviation, median and percentiles of a continuous distribution	2
Normal distribution	2
Uniform and exponential distribution	2
Distributions of functions of a random variable	2
Sums/differences/scalar multiples of random variables, independent random variables, distributions of sums/differences of independent random variables	2
Central Limit Theorem	2
Normal approximation to the binomial distribution, distribution of the sample mean	2
Distribution of sample proportion	2
Stochastic processes, Markov chains	2
Limiting behaviour of Markov chains	2

Course Code: 24BLMT24402

Number of Credits: 2

Course Name: Statistics

Type: Practical

NEP Vertical: Skill Enhancement Course (SEC)

Number of lectures: 30

Statistics (30 lectures)	
Study design: bias, confounding, precision, comparison, control	1
Study design: observational studies vs designed experiments	2
Exploratory data analysis: describing and displaying categorical data (tables, frequencies, bar chart)	2
Exploratory data analysis: describing and displaying univariate numeric data (dotplots, boxplots, histograms, mean, median, quartiles/percentiles, standard deviation, variance, IQR)	2
Exploratory data analysis: describing and displaying bivariate numeric data (scatterplot, correlation)	2
Statistical modeling (single mean model, multiple means model, regression model)	2
Sampling distributions: population vs sample, parameter vs statistic; distribution of sample mean, proportion; standard error	2
Estimation: Confidence intervals, confidence interval for mean (using z), confidence interval for mean using t	2
Estimation: confidence interval for difference in mean, confidence intervals for proportion	2
Estimation: required sample size, confidence interval vs prediction interval	2
Theory of estimation: unbiased estimators, maximum likelihood estimators	2
Hypothesis testing: concepts and terminology, testing a single mean (z and t)	1
Hypothesis testing: errors, power, 2-sample test, paired test, testing proportion	1
Hypothesis testing: Non-parametric tests for 2 samples	1
Partitioning of variability in regression, significance testing in regression	1
Comparing multiple means: one-way ANOVA	1

Chi-squared test for independence	1
Regression: least squares method	1
Chi-squared goodness-of-fit	1
Theory of ANOVA	1

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Course Code: 24BLCEP24601

Number of Credits: 2

Course Name: Community Engagement & Services

Type: Practical

NEP Vertical: Community Engagement & Services(CEP/CES)

Number of lectures: 60

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

Course outcome:

CO1: The student should be able to identify the problems of community

CO2: the student should be able to apply the knowledge gained for the community.

It offers an opportunity to the students to work for the community.

The community could be of any type.

Students will be assigned the on campus faculty/ research scientists from various national research institutes under whose guidance the student would work on a problem by visiting the communities..

The supportive laboratory work/ data analysis is expected.

This would train the students to get the experience of the problems of the community and apply the knowledge to resolve it.

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

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