B.Sc. (Blended) PHYSICS MAJOR Program

Savitribai Phule Pune University

Revision and Amendment

B. Sc. (Blended) **PHYSICS MAJOR**

Four Year undergraduate program

Syllabus for SEM I – IV (**88 Credits**)

In accordance with guidelines of NEP 2020

(To Be Implemented from Academic Year 2023 – 2024)

Semester 1			
	Course Name	Title allocation as per NEP	
PHY 101 MJ (T)	Introductory Classical Physics +Python for physics	DSC(Discipline Specific Course)- Major Core	**4**
PHY 101 MJ (P)	Physics Practical	DSC(Discipline Specific Course)- Major Core	**2**
CC 101 CHE (T)	Introductory and Organic Chemistry	Curricular course	**2**
SEC 101 CHE (p)	Chemistry Practical	Skill Enhancement Course (SEC)	**2**
GE 101 MTS (T)	Calculus	GE (General Elective)/OE(Open Elective)	**4**
VEC 101 BIO (T)	The Diversity of Life	VEC(Value Education Course)	**2**
VSC 121 BIO (p)	Biology Practical	VSC(Vocational Skill course)	**2**
AEC 101 ENG	English,/Critical Thinking / Communication skill	AEC(Ability Enhancement Course)	**2**
PHY 101 IKS	Indian Knowledge System	IKS (Indian Knowledge System)	**2**
			22

1 Credit = 12+3 hours (12 hrs. teaching and 3 hrs. assessment)

PHY 101 MJ (T)	4 Credits
Classical Mechanics	**No. of lectures**
Straight line motion	10
Vectors	
Two-and three-dimensional motion	
Force and Motion: Newton's Laws	
Force and Motion: Drag and Friction	
Kinetic energy, work, power	
Potential energy, conservation of energy	
Collisions and momentum	
Rotational motion	
Angular momentum-I	
Angular momentum-II	
Gravitation	**No. of lectures**
Newton's law of gravity, superposition	5
Gravity at the earth's surface, far above the earth and within the earth	
Work and gravitational potential energy	
Kepler's laws: the planets and satellites	
Orbital motion and energy	
Thermal physics	**No. of lectures**
Zeroth Law of Thermodynamics	10
Thermal expansion and absorption of heat First Law of Thermodynamics; adiabatic processes, constant volume processes, enthalpy, cyclical processes, free expansions	
Heat transfer, conduction, emission, absorption. Second Law of Thermodynamics, Irreversible processes, entropy, free energy	
Elasticity, fluids and gases	**No. of lectures**
Equilibrium and elasticity	5
Density and Pressure, Pascal's and Archimedes' Principles	

Continuity and Bernoulli's Equation	
Ideal gases (Kinetic theory of gases)	
Mean free path, molecular speed distribution	
Specific heat, adiabatic expansion	
Real world examples - eg wind power, hydro, blood circulation, water in plants, materials, osmosis, wind and atmosphere	
ODEs	**No. of lectures**
Applications of 2nd order ODEs: Springs	6
Applications of 2nd order ODEs: LRC series electrical circuits	
Real world contextual examples in physics and application of ODEs	
PYTHON I	**No. of lectures**
Introduction to python programming, basic arithmetic and Hello world programs • Variables, Operators and Datatypes; Operations on datatypes; Input and Output • Functions: Modules, Built-in functions, User defined functions, keyword arguments • Conditional statements (if, elif, else) and Loops.	12

PHY 101 MJ (P)	**2 Credits**
	No. of lectures
1.Simple Pendulum: To plot a L-T2 graph using a simple pendulum and find the effective length of the simple pendulum for a given time period using the graph. To calculate the acceleration due to gravity at a place.	3
2.Torsional Pendulum: To find the moment of inertia of the disc and the rigidity modulus of the material of the suspension wire subjected to torsional oscillations.	3
3. Young's Modulus: To determine the Young's modulus of elasticity of the material of a given wire using Searle's apparatus.	3
4. Measurement of coefficient of Viscosity.	3
5. Measurements using various instruments and error analysis.	3

CC 101 CHE (T)	**2 Credits**
General Chemistry	**No. of lectures**

The Periodic Table	4
Molecular Structure and Bonding	
Acids and Bases	
Stoichiometry	
Organic Chemistry	**No. of lectures**
Carbon – the basis of life	10
Structure and Bonding Alkanes (sp^3Hybridisation)	
Structure and Bonding Alkenes (sp^2Hybridisation)	
Benzene and its derivatives	
Structure and Bonding of Alkynes (sphybridisation)	
Functional Groups	
Electrophiles and Nucleophiles	
Nucleophilic substitution reactions	
Elimination reactions	
Addition reactions	
Electrophilic aromatic substitution reactions	
Nucleophilic addition reactions	
Organic redox reactions	
ODEs	**No. of lectures**
Applications of 1st order ODES: ecology models	4
Applications of 1st order ODES: chemical reaction rates, Newton's law of cooling	
Second-order ODEs: definitions of homogeneous/inhomogeneous, linear/non-linear; solution of homogeneous constant-coefficient linear ODEs	
Physical Chemistry	**No. of lectures**
First Law of Thermodynamics; adiabatic processes, constant volume processes, enthalpy, cyclical processes, free expansions	6
Second Law of Thermodynamics, Irreversible processes, entropy, free energy	
Real world examples - eg solar energy, geothermal, wind power	

SEC 101 CHE (P)	2 Credits
Physical chemistry experiments (Any 3)	**No. of lectures**
To determine the rate constant of the hydrolysis of Ethyl acetate using an acid catalyst.	2
Molar mass determination of some base metals, gases.	2
Determination of dissociation constant of a weak acid.	2
Determination of heat capacity of a calorimeter for different volumes using change of enthalpy data of a known substance.	2
Calculation of the enthalpy of ionization of ethanoic acid.	2
To determine the rate constant of the hydrolysis of Ethyl acetate using an acid catalyst.	2
Inorganic chemistry experiments Any three	**No. of lectures**
Basic Analytical Terms: Volumetric and Gravimetric analysis, Titration, Types of titration viz. acid base, redox, iodometric, iodometric and complexometric titrations, Types of indicators, Selection of indicator, Aquametry (Karl-Fisher titration)	2
Oxalate Complexes of Aluminum and Chromium.	2
Estimation of Fe (II) with K2Cr2O7 using internal external (diphenylamine, anthranilic acid) and external indicator.	2
Estimation of sodium carbonate and sodium hydrogen carbonate present in a mixture.	2
Estimation of Fe (II) and oxalic acid using standardized KMnO4 solution.	2
Organic chemistry experiments	**No. of lectures**
1. Techniques: Crystallization, Sublimation, Distillation, Steam Distillation, Vacuum Distillation, Column Chromatography, Thin Layer Chromatography. Record melting point & Boiling Point.	2
2. Functional group tests following functional groups Alcohols, Alkenes, Aldehydes and Ketones, Acids, Phenols, Amines, Amides, Esters, Aromatic compounds.	2
3. Preparations: (Any 3)	2

a. Preparation of 4, 4'-Dimethoxy-dibenzylideneacetone b. Preparation of 4-tert-Butylphenol c. Reduction of p-nitro benzaldehyde by sodium borohydride d. Nitration of Salicylic acid by green approach (using ceric ammonium nitrate). e. Bromination of cinnamic acid.	

GE 101 MTS (T)	**4 Credits**
Logic and Proof	**No. of lectures**
Basic set theory (review)	12
Logical connectives (conjunction, disjunction, negation, conditional, bi-conditional) and truth tables	
Propositional logic, logical equivalence, logical laws	
Real numbers and their properties; completeness property	
Proof methods: direct proof, contrapositive	
Proof methods: contradiction, proof by cases	
Proof methods: induction	
Natural numbers, integers, rational numbers	
Real numbers	
Complex Numbers	**No. of lectures**
Review of complex numbers including algebra, Argand plane, cartesian and polar form	6
Complex exponential	
de Moivre's theorem; roots of complex numbers	
Differential calculus	**No. of lectures**
Review of differential calculus: limits, derivative, differentiation rules incl. polynomials, trigonometric, exponential, log functions; product, quotient, chain rules	6
Review of inverse trigonometric functions and their derivatives, implicit differentiation	6
Integral calculus	**No. of lectures**
Riemann integration	

Fundamental Theorem of Calculus; review of standard anti-derivatives	18
Techniques of integration (review): derivative present substitution, linear substitution	
Techniques of integration (review): integration of trigonometric functions using identities	
Techniques of integration (review): integration of rational functions including partial fractions, integration yielding inverse trig functions	
Techniques of integration (review): trigonometric substitutions; integration by parts	
Improper integrals	
Applications of integration: areas between curves	
Applications of integration: volumes of surfaces of revolution	
Ordinary differential equations: definition of ODE, order, general solution, initial conditions; separable ODEs	
Solving linear ODE using integrating factor	
Particular solutions of inhomogeneous constant coefficient linear ODEs using method of undetermined coefficients; principle of superposition	

VEC 101 BIO (T)	**2 Credits**
Evolution and the Diversity of Life	**No. of lectures**
Theory of evolution: understanding life's diversity	12
Evolutionary relationships (phylogenies) are summarized in classifications	
Chemical evolution of life – Molecules to cells	
Cell theory and the origin of life	
Prokaryotic Cells: Bacteria and Archaea	
Evolution of the eukaryotic cell	
Endosymbiosis	
Protists 1 - Red and Green algae	
Protists 2 – Chromists	
Protists 3 - Dinoflagellates and apicomplexans, flagellates, ciliates, amoebae	
Evolution of sex, life cycles	

Origins of multi multicellularity	**No. of lectures**
Slime molds and fungi	12
Fungi	
Introduction to Land Plants	
Bryophytes	
Evolution of vascular tissue, Lycophytes, fern allies, early fossil land plants	
Ferns	
Seed plants, the seed and secondary growth, Cycads and Ginkgo	
Conifer diversity and biology	
Angiosperm structure, biology and diversity, the flower, double fertilization.	
Angiosperm phylogeny and evolution	
Introduction to animals (Metazoa)	
Simple animals	
Protostomes-Flatworms and annelids	
Molluscs	
Arthropods	
Deuterostomes, Echinoderms-Chordates	
Fishes –sharks/rays, teleosts, coelacanth, lungfish	
Amphibians	
Reptiles	
Birds	
Mammals	
The Primate story	

VSC 121 BIO (P)	**2 Credits**
	No. of lectures
1. Observation of zooplankton from pond samples under microscope	2
2. Determination of dissolved oxygen in water sample using Winkler titration	2

3. Collection and identification of invertebrate samples from pond by using different types of nets.	2
4. Visit to the museum at zoology department at Pune University and observe the collected specimens.	2
5. Using a taxonomic browser to identify the taxonomic lineage and explain key characteristics of the species.	2
6. Observe the characteristics of prokaryotic and eukaryotic cells.	2

AEC 101 ENG			**2 Credits**
Sr. no	**Theory**	**Practical**	**No. of lectures**
1	**Listening -** Overview, Question Types, Listening Tips, Completing the blanks, Making Assumptions, understanding numbers Understanding the alphabet, Distinguishing similar sounds	Listening for - Description, Time, Frequency, Similar meanings, Emotions, Explanation, Classification, Comparison and contrasts, Negative meaning, Chronology	12
2	**Reading-** Overview, Question Types, Reading Tips	Using first paragraph to make predictions, Using the topic sentence to make predictions, looking for specific details Analyzing Questions and Answers, Identifying the tasks	12

PHY 101 IKS	**2 Credits**
Indian Rhetoric	**No. of lectures**
Rhetoric as Everyday Experience: Persuasion & Convincing: Advt. & Campaigns Arguments and Debates: Courtrooms to Politics Historical context of Classical Rhetoric in Greece Democracy, Public Opinion and Rhetoric	6
Rhetoric: Elements & Versions Context and Intent Appeals & Arrangement Instruments & Ornamentation Culture, History and Versions of Rhetoric	6

1Nyay Shastra- Indian Framework of Debate Brief background and premise Basic elements, of Nyay Shastra Logic and arrangement Good & Bad forms of Debate	6
Natya Shastra Brief background and premise Basic elements of Natya Shastra Sahahridaya & Sadharanikarn Rasa & Bhaav	6

OR

PHY 101 IKS	**2 Credits**
Vedic Mathematics	**No. of lectures**
Vedic Mathematics: Brief History Mathematics in Ancient India. Relevance & Utility of Vedic Mathematics Contributions by Aryabhata & Brahmagupta Contributions by Mahaveer Acharya & Bharti Krishna Tirtha	5
Application of Vedic Mathematics Multiplication of two numbers of two digits Multiplication of two numbers of three digits multiplication of two numbers of three digits Nikhilam Navtashchramam Dashtaha	5
Division and Divisibility Two digits divisor Three digits divisor Divisibility- Two digits divisor	5
Power and Root Power: Square (two-digit numbers) Cube (two-digit numbers). Square root (four-digit number) Cube root (six-digit numbers)	5
LCM and HCF	4

Semester 2			
Course Code	Course Name	Title allocation as per NEP	After
PHY 151 MJ (T)	Modern Physics	DSC (Discipline Specific Course)- Major Core	4
PHY151 MJ (P)	Physics Practical	DSC (Discipline Specific Course)- Major Core	2
CC 151 CHE (T)	Inorganic and Physical Chemistry	Curricular Course	2
SEC 151 CHE (p)	Chemistry Practical	Skill Enhancement Course (SEC)	2
GE 151 MTS (T)	Algebra	GE (General Elective)/OE (Open Elective)	4
VEC 151 BIO (T)	Biology of Cells	VEC (Value Education Course)	2
VSC 171 BIO (p)	Biology Practical	VSC (Vocational Skill course)	2
AEC 151 ENG	English, /Critical Thinking / Communication skill	AEC (Ability Enhancement Course)	2
PHY 191 MN	interdisciplinary elective	Minor	2
Total			**22**

1 Credit = 12+3 hours (12 hrs. teaching and 3 hrs. assessment)

PHY 151 MJ (T)	4 Credits
Electricity and Magnetism	**No. of lectures**
Electric charge, conductors and insulators	18
Coulomb's Law, superposition principle	
Electric field, superposition principle	
Electric flux	
Gauss's law, applications	
Energy and electric field; electric potential	
Calculating potential from the field, electric potential, potential energy surfaces.	
Electric dipoles	
Capacitance; parallel plate capacitors	
Energy storage in capacitors, dielectrics, series and parallel circuits	
Conductors, electric current, electric power, Ohm's law	
Kirchoff's rules, resistors in series and parallel circuits	
Magnetic field, magnetic force, Lorentz force, cyclotrons	
Lorentz force, ion velocity filter, Hall effect, Biot-Savart Law	
Bio-Savart Law, Ampere's Law, solenoids, earth's magnetic field	
Magnetic field due to a current, forces on current-carrying wires, Electromagnetic induction, magnetic flux	
Lenz' Law, Faraday's law, Maxwell's equations, applications	
Magnetic materials	
Oscillations and Waves	**No. of lectures**
Simple harmonic motion, pendulum, diatomic molecules, Damped harmonic motion, resonance - electronic circuits, evolution of populations	6
One dimensional waves, Interference and standing waves, Sound waves and the speed of sound, Intensity, sound level and the physics of music	
Doppler effect and supersonic motion, shock waves	
Optics	**No. of lectures**

Images and mirrors	6
Thin lenses and optical instruments	
Young's experiment, interference	
Thin films and the Michaelson interferometer	
Diffraction by slits and apertures	
Diffraction by gratings and X-ray diffraction	
Optical Microscopy	
Spectroscopy	
Modern Physics	**No. of lectures**
Challenges to classical physics; special relativity	6
Lorentz transformation, transformation of velocities, Doppler effect	
Relativistic momentum and energy	
Photons and the photoelectric effect	
Quantum physics, blackbody radiator, matter waves	
Trapped particles and the tunneling particles	
Nuclear physics, nuclear properties, nuclear decay	
Quarks, Leptons, The Big Bang	
PYTHON -II	**No. of lectures**
• Lists, Strings, Tuples and Dicts • Introduction to numpy • Introduction to matplotlib for basic plotting	12

PHY 151 MJ (P)	**2 Credits**
	No. of lectures
1. Verification of Kirchhoff's Law.	3
2. Study of RC circuit and calculation of time constant.	3
3. To find the Force constant of a helical spring.	3
4. To determine the refractive index and dispersive power of the prism using the spectrometer	3
5. Determine the wavelength of laser using (i) diffraction grating and (ii)single slit	3

CC 151 CHE (T)	2 Credits
Chemistry of Life	**No. of lectures**
The chemical basis of life	6
Bioenergetics	
Enzymes and catalyzed reactions	
Metabolism: Catabolism and anabolism	
Concatenation and Biopolymers	
Stereochemistry and Biomolecular chirality	
Biochemistry and Biomolecular structure	
Small inorganic molecules of biological importance	
Inorganic Chemistry	**No. of lectures**
Ionic Compounds and their Solutions	10
Structures of Solids	
Main Group Chemistry	
Redox reactions and electrochemistry	
The transition metals: a survey	
Coordination Chemistry	
Bonding in complex ions	
Transition metals in biological systems	
Simple harmonic motion, pendulum, diatomic molecules	
Quantum Chemistry	**No. of lectures**
Schrödinger's equation and Heisenberg's Uncertainty Principle	8
Bohr and Schrodinger models of the hydrogen atom	
Complex atoms; Pauli Exclusion Principle, Periodic Table of Elements, selection rules and spectra	
Nuclear fission and fusion	

SEC 151 CHE (P)	2 Credits
Physical chemistry experiments (Any 3)	**No. of lectures**

To determine the rate of chemical reaction by using hydrolysis of *tert*-Butyl chloride.	2
Effects of catalase enzyme obtained from potato in cleaving H_2O_2 into H_2O and O_2.	2
To measure the vapour pressure of n- Pantane by using high vacuum line.	2
Heat of solution of KNO_3/ NH_4Cl.	2
Glass electrode- Buffer solutions: To titrate a weak base (Na_2CO_3) with a strong acid: a) an acid-base indicator, (b) a glass electrode	2
Inorganic chemistry experiments (Any 3)	**No. of lectures**
Synthesis of hexamminenickel (II) $[Ni(NH_3)_6]I_2$	2
Cuprous Chloride, Cu_2Cl_2	2
The transition metals: a survey (Transition metals in biological systems and Bonding in complex ions).	2
Estimation of Cu(II) and K2Cr2O7 using sodium thiosulphate solution (Iodimetrically).	2
Estimation of available chlorine in bleaching powder iodometrically.	2
Organic chemistry experiments	**No. of lectures**
1. Preparation of Derivatives:	
Oxime, 2, 4-DNP, Acetyl, Benzoyl, Semicarbazone, Anilide, Amide, Aryloxyacetic acid.	2
2. Organic single stage preparation: (Any 3) 1. The preparation of paracetamol. 2. The synthesis of meso-1,2-Dihydroxy-1,2-Diphenylethane. 3. Preparation of ά-phenyl Cinnamic acid from Benzaldehyde. 4. Preparation of benzyl alcohol from Benzaldehyde 5. Preparation Glucose pentaacetate from Glucose. 6. Preparation of 2-iodobenzoic acid from Anthranilic acid.	2
3. **Use of Computer (Chemistry Software)** – Chem Draw-Sketch, ISI – Draw, Draw the structure of simple aliphatic, aromatic, heterocyclic organic compounds with substituents. Get the correct IUPAC name.	2

GE 151 MTS (T)	4 Credits
Analysis	**No. of lectures**
Limits of real-valued functions	12
Proving limits using the definition	
Continuity & differentiability	
Examples of differentiable and non-differentiable functions; continuity and differentiability of standard functions including polynomials, trigonometric, exponential, log functions and their inverses	
Techniques for evaluating limits including L'Hopital's rule, sandwich theorem	
Mean Value Theorem and applications	
Applications of differential calculus eg related rates	
Sequence and series	**No. of lectures**
Sequences, limits, convergence and divergence	**12**
Proving limits using definition	
Methods for evaluating limits: standard limits, limit theorems, continuity rule, sandwich theorem	
Series, convergence and divergence of series, geometric series, harmonic p-series	
Series convergence tests: divergence test, comparison test	
Series convergence tests: ratio test, integral test, alternating series test	
Power series, Taylor polynomials	
Taylor series	
Taylor's theorem, error in Taylor polynomial estimates	
Vectors	**No. of lectures**
Vector arithmetic, dot product, vector projections (review)	6
Vector cross product; scalar triple product; parametric curves specified by vector equations	
Lines and planes in R^3	
Lines and planes in R^3	

Linear Algebra 1	**No. of lectures**
Solving systems of linear equations with Gaussian elimination	18
Solutions of systems of linear equations - consistency, uniqueness	
Geometric interpretation of solutions	
Matrices, matrix addition, multiplication, transpose and properties (review)	
Matrix inverse	
Determinant	
R^n as a vector space, linear independence of vectors in R^n	
Span of a set of vectors, subspaces of R^n	
Basis and dimension in R^n	
Abstract vector space axioms; examples and non-examples of vector spaces	
Bases, dimension and co-ordinates in (finite dimensonal) abstract vector spaces	
Definition of linear transformation and examples/non-examples	
Linear transformations of the plane	
Matrix representation of a linear transformation	
Image and kernel of a linear transformation	
Rank and nullity	

VEC 151 BIO (T)	**2 Credits**
The Biology of Cells	**No. of lectures**
Introduction to Cell Biology	2
Theme: The cell contained	**No. of lectures**
The plasma membrane	6
Cell walls, extracellular matrix, cellulose synthesis, other cell wall components	
Cytoplasm: content, chemistry and properties	
Cytoskeleton, actin filaments, microtubules	
Theme: Information flow in the cell	**No. of lectures**

Nucleus, chromosomes, DNA	4
Genes and the genetic code	
Control of gene expression	
Theme: Endomembrane system and intracellular trafficking	**No. of lectures**
ER and ribosome, proteins and enzymes	6
Golgi apparatus	
Vesicles, transport and secretion, Lysosomes	
Theme: Harvesting energy	
Mitochondria, ATP, energetic reactions, electron transport pathways, cellular respiration	
Chloroplasts, photosynthesis, historical experiments, pigments, photosystems	
Theme: Multicellularity and the Dividing Cell	**No. of lectures**
Cell division, cell cycle, mitosis, cytokinesis, division and distribution of organelles	6
Meiosis, formation of haploid cells	
Communication and signaling, recognizing and responding	
Cell differentiation and multicellularity	

VSC 171 BIO (P)_	**2 Credits**
	No. of lectures
1. Microscopy and observation recording of representative organelle readymade specimens	2
2. Staining of cell for observations of- Flagella, cell wall, endospores, etc. a. Plant call, bacterial, fungi samples b. malachite green, safranin, Leifson flagella stain/RYU flagella stain, nitric acid, crystals of potassium chlorate	2
3. Introduction and visualization DNA-Proteins in silico	2

4. A one day visit to IISER Pune for electron/ fluorescence microscopy observations	2
5. Observation of budding in yeast & different kinds of cells	2
6. Observation of live/dead cells using Trypan blue staining	2
7. Isolation of DNA	2
8. Mitosis in onion root tips	2

AEC 151 ENG			**2 Credits**
Sr. no	**Theory**	**Practical**	**No. of lectures**
1	**Writing-** Overview, Question types, Writing tips	Responding to task, Coherence and cohesion, Lexical resource, Generalizing and Qualifying, Grammatical range and accuracy	12
2	**Speaking-** Overview, Question type, Speaking tips	Introduction and Overview, Giving Information, Organizing and discussing a topic, Sequence, Comparing and contrasting Respond to follow up questions, ask for clarification, Avoid short answers, Transition and intonation	12

PHY191MN	**2 Credits**
Basic of Astrophysics	**No. of lectures**
Astronomical Scales: Astronomical Distance, Mass and Time, Scales, Brightness, Radiant Flux and Luminosity, Measurement of Astronomical Quantities Astronomical Distances, Stellar Radii, Masses of Stars, Stellar Temperature. Astronomical techniques: Basic Optical Definitions for Astronomy (Magnification Light Gathering Power, Resolving Power and Diffraction Limit, Atmospheric Windows), Optical Telescopes (Types of Reflecting Telescopes, Telescope Mountings, Space	12
Telescopes, Detectors and Their Use with Telescopes (Types of Detectors, detection Limits with Telescopes).	12

The sun (Solar Parameters, Solar Photosphere, Solar Atmosphere, Chromosphere. Corona, Solar Activity, Basics of Solar Magneto-hydrodynamics. Helioseismology). The solar family (Solar System: Facts and Figures, Origin of the Solar System: The Nebular Model, Tidal Forces and Planetary Rings, Extra-Solar Planets.	

OR

PHY191MN	**2 Credits**
Renewable Energy and Energy Harvesting	**No. of lectures**
Fossil fuels and Alternate Sources of energy Fossil fuels and nuclear energy, their limitation, need of renewable energy, non-conventional energy sources. An overview of developments in Offshore Wind Energy, Tidal Energy, Wave energy systems, Ocean Thermal Energy Conversion, solar energy, biomass, biochemical conversion, biogas generation, geothermal energy tidal energy, Hydroelectricity	12
Solar energy its importance, storage of solar energy, solar pond, no convective solar pond, applications of solar pond and solar energy, solar water heater, flat plate collector, solar distillation, solar cooker, solar green houses, solar cell, absorption	12

Semester 3			
Course Code	Course Name	Title allocation as per NEP	**credit**
PHY 201 MJ (T)	Quantum Mechanics and Thermodynamics	DSC(Discipline Specific Course)-Major Core	**6**
PHY 201 MJ (P)	Physics Practical	DSC(Discipline Specific Course)-Major Core	**2**
CC 201 CHE (T)	Chemistry: Reactions and Synthesis	Curricular Course	**2**
MN 241 MTS (T)	Vector Calculus and Differential Equations	Minor	**4**
GE 201 BIO (T)	Functional Biology of Organisms	GE (General Elective)/OE (Open Elective)	**2**
VSC 221 BIO (p)	Biology Practical	VSC (Vocational Skill course)	**2**
AEC 201 ENG	English/Critical Thinking / Communication skill	AEC (Ability Enhancement Course)	**2**
PHY 231 FP	Field Project	FP (Field Project)/OJT (On job training)/CEP	**2**
Total			**22**

1 Credit = 12+3 hours (12 hrs. teaching and 3 hrs. assessment)

PHY 201 MJ (T)	6 Credit
Quantum Mechanics	**No. of Lectures**
The Breakdown of Classical Physics	**18**
Matter Waves and Quantum Interpretation	
Quantum Mechanics in One Dimension	
Expectation Values, Observables and Operators	
Tunneling Phenomena	
Quantum Mechanics in 3-dimensions	
Hydrogen atom, hydrogenic ions, helium atom	
Hydrogen molecule ion, hydrogen molecule	
Thermodynamics	**No. of Lectures**
Temperature and the Zeroth Law of Thermodynamics. Thermal equilibrium. Ideal gases, the kinetic theory of gases, equipartition theory, Boltzmann distribution	12
Heat, work, internal energy. First law of thermodynamics. Compression of an ideal gas under various conditions. Transport, conduction, conductivity, diffusion in gases.	
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	
Second Law of Thermodynamics. Heat engines, Carnot Cycle, Otto Cycle, Stirling Cycle.	
PDEs	**No. of Lectures**
Wave equation	2
Heat and Diffusion equation	
Linear Algebra	**No. of Lectures**
Change of basis and linear transformations	4
Definition of eigenvectors and eigenvalues	
Calculating eigenvalues and eigenvectors	
Diagonalization of matrices; matrix powers	
Orthogonal matrices, real symmetric matrices	

PYTHON III	**No. of Lectures**
Object Oriented Programming: Classes, Inheritance • Exception handling • Basic File Handling • Introduction to pandas: extraction of data from CSV, XLSX and TXT files. • Basics of GUI Programming using tkinter	12

PHY 201 MJ (P)	**2 Credit**
	No. of lectures
1. To determine the Wavelength of main spectral line of mercury light using (1) plane transmission grating. (2)using single slit.	3
2. Verification of Stefan's Law by electrical method.	3
3. Determine of the wavelength of sodium light by measuring the diameters of Newton's ring.	3
4.To determine coefficient of Linear Expansion using Pullinger's method	3
5. To determine the coefficient of thermal Conductivity of bad conductor by Lee's Disc.	3

CC 201CHE (T)	**2 Credit**
Reactions and Synthesis 1	**No. of 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.	
Carbonyl Compounds and Reactions: Carbonyl compounds, tautomerism as a general phenomen, keto-enol tautomerism of carbonyl compounds, mechanism of keto-enol tautomerism	8

Generating enolate anions, suitable base catalysts for enolising aldehydes, ketones ester and β-dicarbonyl compounds, general α-substitution reaction	
Reactions of enols and enolates, α-substitution with H/D^+ Stereochemical consequences and deuterium incorporation. Halogenation of carbonyl compounds, The haloform reaction	
Halogenation of carbonyls, Hell-Volhard-Zelinsky reaction. Synthetic applications of a-halo carbonyl compounds	
Alkylation of enolates, LDA, scope and limitations	
Aldol reaction, mechanism and retrosynthesis, inter-and- intra-molecular variants, mixed Aldol reaction	
Claisen reaction, mechanism and retrosynthesis, mixed Claisen and Deickman reaction.	
Malonate Diester Chemistry, Acetoacetate chemistry, Synthesis of substituted acetic acid and acetone derivatives. Scope, Mechanism and Retrosynthesis.	
Michael addition Chemistry, reaction of enolates with various Michael electrophiles	
Kinetic and Thermodynamic enolates, Enamines and silylenol ethers	
Reactions and Synthesis 2	**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.	8
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?)	
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.	

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.	
Nernst equation revisited and construction and uses of Poubaix diagrams combining redox and acid base reactions. Comparison of chemistry of representative elements as reflected in Pourbaix diagrams.	
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.	
Hard/soft acid/base theory. Thermodynamic basis for HSAB theory. Usefulness in predicting direction of equilibrium and solubility.	
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.	
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 *etc* in octahedral complexes.	
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	
Thermodynamics	**No. of lectures**
Heat, work, internal energy. First law of thermodynamics. Heat capacity and enthalpy. Compression of an ideal gas under various conditions. Latent heats	8

Multiplicity and ideal gases. Entropy, spontaneous change and the Second Law of Thermodynamics	
Interacting ideal gases and the entropy of mixing.	
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	
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	
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	

MN 241 MTS (T)	**4 Credit**
Linear Algebra	**No. of Lectures**
Change of basis and linear transformations	18
Definition of eigenvectors and eigenvalues	
Calculating eigenvalues and eigenvectors	
Diagonalization of matrices; matrix powers	
Orthogonal matrices, real symmetric matrices	
Characteristic and minimal polynomial, Cayley-Hamilton Theorem	
Applications of eigenvectors/diagonalization Markov chains	
Inner product axioms; examples/non-examples of inner products	
Length, angle, Cauchy-Schwarz inequality in terms of inner product	
Orthogonality, projections in terms of inner product	
Gram-Schmidt algorithm	
Vector Calculus	**No. of Lectures**

Functions of several variables; level curves and cross sections of surfaces	18
Common surfaces including paraboloid, ellipsoid, hyperboloid	
Domains and ranges of functions of several variables	
Limits and continuity of functions of several variables; Definition of C^N	
Partial derivatives, tangent plane	
Differentiability of functions of several variables	
Directional derivative, gradient	
Chain rule and total derivative	
Stationary points of surfaces, classification of stationary points using second derivatives	
Optimization applications	
Constrained extrema using Lagrange multiplier method	
Double integrals, changing order of integration	
Polar co-ordinates, change of variables for double integrals	
Triple integrals	
Change of variables for triple integrals; cylindrical co-ordinates	
Spherical co-ordinates	
Vector fields, div and curl operators	
Parameterization of paths	
Line integrals of scalar functions	
Line integrals of vector functions	
Integrals of scalar functions over surfaces, applications of surface integrals eg surface area, mass	
Integrals of vector functions over surfaces, flux	
Green's Theorem	
Gauss Divergence Theorem	
Stokes' Theorem	
Applications of integral theorems eg Maxwell's equations	
PDEs	**No. of Lectures**
Fourier Series	12
Fourier series: Dirichlet, discontinuities and differentiation	
Fourier series: Weak convergence and series summation	

Linearity and Superposition	
Laplace equation and harmonic functions	
Wave equation	
Heat and Diffusion equation	
Fourier transform	
Fourier transform: properties	

GE 201BIO (T) **2 Credit**	
Functional Biology of Organisms	**No. of Lectures**
Introduction to Functional Biology	2
Animal biology (Humans as an example)	
Anatomy and Function 1: Tissues, Organs and Viscera	12
Anatomy and Function 2: Skeletal & Muscular system	
Nervous system 1: The central nervous system (CNS) and nervous tissues	
Nervous system 2: Autonomic nervous system and motor responses	
Endocrine system 1: Endocrine and Exocrine glands	
Endocrine system 2: HPA axis introduction	
Respiration and Metabolism 1: Breathing in air and water	
Respiration and Metabolism 2: Regulation of metabolism	
Cardiovascular and circulatory system 1: Regulation of the circulatory system	
Cardiovascular and circulatory system 2: Peripheral circulation	
Digestive system	
Urinary and Excretion systems 1: Anatomy and function	
Urinary and Excretion systems 2: Osmoregulation in terrestrial & aquatic environments	
Thermal dynamics	
Immunology 1: Innate immune system	
Immunology 2: Adaptive/Humoral immune system	
Reproduction and Development 1: Gonads and the Reproductive tract	

Reproduction and Development 2: Gametes, Fertilization and conception	
Plant biology	**No. of Lectures**
Growth and Development	12
Photosynthesis	
Water Balance	
Phloem and translocation	
Mineral nutrition and nutrient assimilation	
Respiration and lipid metabolism	
Reproduction	
Signaling; hormones, light responses, control of flowering	
Abiotic stress	
Secondary metabolism and defense	
Microbial physiology	

VSC 221 BIO (P) **2 Credit**	
	No. of lectures
1.Bacterial growth: optical density measurement	2
2.Counting of different kind of blood cells using hemocytometer	2
3.Estimation of hemoglobin	2
4.Determination of blood pressure and amount of oxygen in the blood	2
5.Action of salivary amylase in relation to enzyme concentration and temperature	2
6.Demonstration of imbibition	2
7.Demonstration of osmosis in plants	2
8.Demonstration of plasmolysis in onion cells	2
9.Separation of plant pigments by chromatography	2
10.Estimation of chlorophyll in the leaf tissue	2

PHY 251 FP (Any 2)	2 Credit
Field Project in Physics	**No. of Lectures**
Experimental Investigation of Projectile Motion: Set up an experiment to study the motion of projectiles. You can vary parameters such as launch angle, initial velocity, and mass of the projectile, and observe how these factors affect the trajectory and range.	12
Study of Optics in Nature: Explore how light behaves in various natural settings. You could investigate phenomena such as rainbows, mirages, or the optics of animal vision. This could involve field trips to different environments and careful observation and measurement.	12
Solar Energy Harvesting: Design and implement a small-scale solar energy harvesting system. Measure factors such as incident sunlight intensity, efficiency of the solar cells, and the output power generated. This project could involve both theoretical calculations and practical measurements in the field.	12
Seismic Monitoring: Set up seismometers in different locations to monitor seismic activity. Analyze the data collected to study patterns of earthquakes and seismic waves. This project could involve collaboration with geologists and seismologists.	12

Semester 4			
Course Code	Course Name	Title allocation as per NEP	**After**
PHY 251 MJ (T)	Electricity, Magnetism, Special Relativity, and Optics	DSC(Discipline Specific Course)- Major Core	**6**
PHY 251 MJ (P)	Physics Practical	DSC(Discipline Specific Course)- Major Core	**2**
CC 251 CHE (T)	Chemistry: Structure and Properties	Ability Enhancement Course (AEC)	**2**
SEC 251 CHE (p)	Chemistry Practical	Skill Enhancement Course (SEC)	**2**
MN 291 MTS (T)	Probability and Statistics	Minor	**4**
GE 251 BIO (T)	Genetics, Evolution and Ecology	GE (General Elective)/OE(Open Elective)	**2**
AEC 251 PS	English, /Critical Thinking / Presentation skill	AEC(Ability Enhancement Course)	**2**
PHY 281 FP	Field Project	FP(Field Project)/OJT(On job training)/CEP	**2**
Total			**22**

1 Credit = 12+3 hours (12 hrs. teaching and 3 hrs. assessment)

PHY 251 MJ (T)	6 Credit
Electricity and Magnetism	**No. of Lectures**
Coulomb's Law	18
Gauss's Law	
Electric Field, Potential	
Conductors, Insulators	
Laplace equation	
Curl and Stoke's theorem	
Capacitors, capacitance and energy stored in E field	
Current and continuity equation	
Magnetic field and Moving Charges	
Force on Moving charges	
Magnetic Field and vector potential	
Special relativity and E and B fields	
Induction	
Inductance and energy stored in B field	
RC circuits	
CL and RLC circuits	
Displacement current	
Complete Maxwell's Equations	
Electromagnetic Waves	
Dielectrics and Electric Dipoles	
Dielectrics	
Magnetic Dipoles	
Magnetism in Matter	
Special relativity	**No. of Lectures**
Space-time and simultaneity. Einstein axioms for special relativity. The Lorentz transformation.	9
Relativistic kinematics; length contraction, time dilation. Doppler effect. Twin paradox.	
Relativistic dynamics. Mass-energy equivalence. Conservation of four-momentum. Centre of momentum frame. De Broglie waves and photons.	

Einstein, the equivalence principle, gravity, gravitational lenses, gravitational waves (qualitative)	
Nuclear reactions and thermonuclear power.	
Optics- Applications and microscopy	**No. of Lectures**
Classical optics: Fermat's Principle	9
Fourier Optics: Huygens-Fresnel Principle	
Fourier Optics: Fresnel diffraction integral	
Fourier Optics: Paraxial approximation	
Fourier Optics: Fraunhofer diffraction	
Fourier Optics: Apertures and imaging	
Fourier Optics: phase contrast imaging	
Microscopy applications	
PYTHON IV	**No. of Lectures**
Non-Linear Equations: Bisection, False-Position, Newton Raphson and Secant Methods • Numerical Integration: Trapezoidal and Simpson's Rules • Linear Regression • Euler's Method and Runge-Kutta Methods	12

PHY 251 MJ (P)	**2 Credit**
	No. of lectures
1. Study of Charging and discharging of capacitor and calculation of time constant.	3
2. Determination of e/m by Thomson method.	3
3. Determination of the refractive index of a transparent liquid (water) using a hollow prism and spectrometer.	3
4. Study of the graph between refractive index and wavelength for different colors of light and to verify Cauchy's Formula.	3
5.Study of LCR circuit	3
CC 251 CHE(T)	**2 Credit**

Structure and Properties	**No. of Lectures**
Molecular shape and simple electronic structure, Isomerism: Orbitals, hybridization and shapes of molecules, sterochemical consequences of tetrahedral carbon (isomers, enantiomers, R/S, D/L, optical rotation)	4
Stereochemistry – optical activity: Molecules with more than one chiral centre (diastereomers, meso compounds, separation of racemic mixtures)	
Symmetry operations and elements	
Group theory: Definition of reducible and irreducible representations, use of group theory to determine the irreducible representation	
Assignment of point groups	6
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 – *e.g.* dipole moment, possible optical isomers, Orbital symmetry labels (*e.g.* s, p & d orbitals in T_d, O_h, D_{4h})	
Stereochemistry and Reactions: Prochirality, chirality in Nature, Sterochemistry on atoms other than carbon, Retrosynthetic analysis	
Stereochemistry and Mechanism (nucleophilic substitution, elimination from non-cyclic compounds)	
Alkene addition reactions – Hydrogenation, halogenation, HX addition. Elimination Reactions epoxide ring forming reactions	
Zeeman effect: Effect on the energies of a system by application of a magnetic field; Magnetochemistry, spin and orbital contribution to the magnetic moment	
Magnetic resonance spectroscopies: EPR spectroscopy, hyperfine coupling application to organic radicals and to transition metal complexes	
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	
^{13}C NMR, ^{1}H NMR, integration, multiplicity, chemical shift typical ranges	

Introduction to molecular spectroscopy and spectroscopic transitions, absorbance, transmittance, the Beer-Lambert Law, intensities of spectroscopic transitions	
Quantised vibration and simply harmonic oscillator model, wave functions,	6
Molecular vibrational modes, vibrational spectroscopy infrared and Raman spectroscopy 3N-5, 3N-6 vibrational degrees of freedom	
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 RN H_2 and R_2NH, carboxylic acid, amide, ester, ketone, aldehyde, nitrile RCN, alkyne, alkene, aromatic), fingerprint regions, interpretation of IR spectra	
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	
Photoelectron spectroscopy	
Generalisation of the application of MO approaches to polyatomic molecules	
Hückel Theory	
Aromatic and Heterocyclic Chemistry of compounds with delocalised p 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 (*e.g.* pyridine and pyrrol). Non C-based aromatic systems	10
Electronic spectroscopy: Chromophores and excited electronic states, electronic transitions, UV-Vis spectroscopy, Franck-Condon Principle, Franck-Condon factors	
Fates of electronic excited states – fluorescence and phosphorescence, non-radiative transitions, internal conversion and intersystem crossing, fluorescence spectra	
Applications – light emitting polymers	

Organometallic chemistry. Types and broad applications of organometallic complexes and catalysts. Ligand types and examples.	
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	
Covalent interactions in coordination compounds – rationalisation of spectrochemical series in terms of bonding interactions	
Binary metal carbonyl complexes Synergistic bonding and the 18-electron rule. IR and NMR spectroscopy	
Substitution at metal carbonyl. Other organometallic ligand types and complexes thereof. Alkyne and alkene complexes. *etc.*	
Redox reaction in organometallic chemistry. Hydrogen complexes and oxidative addition reactions. Reductive elimination reactions. Activation and reactions of organometallic ligands. Insertions, migrations.	
Catalysis involving transition metals : Catalytic systems. Water gas shift reaction, hydrogenations, acetic acid process etc. Metallocene complexes and their chemistry leading to advanced polymerization catalysts etc.	

SEC 251 CHE (P)	**2 Credit**
Physical chemistry experiments (Any 3)	**No. of lectures**
Determination of the stability constant of a complex by spectrophotometry.	2
The reaction between potassium persulphate and potassium iodide by colorimetry.	2
Determine the formula and stability constant of a metal ion complex (Lead Oxalate) by polarography.	2
Analysis of copper oxide and copper dioxide to determine law of multiple proportions.	2
Behaviour of water at different temperatures	2
Inorganic chemistry experiments (Any 3)	**No. of lectures**
Photometric Analysis - To study complex formation between Fe (III) and salicylic acid and find the formula and stability constant of the complex.	2

Simultaneous determination of Cr+2 and Cu+2	2
To determine the strength of given mixture of carbonate and bicarbonate in the given mixture by pH metric method.	2
Determination of chemical oxygen demand (COD)	2
Determination of Biological oxygen demand (COD)	2
Organic chemistry experiments (Any 3)	**No. of lectures**
Organic Preparations: Double Stage	2
Glycine – Hydantoic acid – Hydantoin	2
Benzoin – Benzil - Benzilic acid	2
P-cresol – 4,6-Dimethylcoumarin – 3-Bromo-4,6 Dimethyl Coumarin	2
Benzophenone – Oxime – Benzanilide	2
Acetanilide – p-Bromoacetanilide – p-Bromoaniline	2
Hydroquinone – Quinoline – 1,2,4 – Triacetoxybenzene.	2

MN 291 MTS (T)	**4 Credit**
Probability	**No. of Lectures**
Review of probability, events, laws of probability	20
Conditional probability, independent events	
Random variables; discrete random variables and distributions; mean, variance and standard deviation of discrete random variable	
Bernoulli trials, binomial distribution	
Poisson distribution and Poisson process	
Continuous random variables and distributions, probability density functions, cumulative distribution function	
Mean, variance, standard deviation, median and percentiles of a continuous distribution	
Normal distribution	
Uniform and exponential distribution	
Distributions of functions of a random variable	

Sums/differences/scalar multiples of random variables, independent random variables, distributions of sums/differences of independent random variables	
Central Limit Theorem	
Normal approximation to the binomial distribution, distribution of the sample mean	
Distribution of sample proportion	
Stochastic processes, Markov chains	
Limiting behavior of Markov chains	
Statistics	**No. of Lectures**
Study design: bias, confounding, precision, comparison, control	28
Study design: observational studies vs designed experiments	
Exploratory data analysis: describing and displaying categorical data (tables, frequencies, bar chart)	
Exploratory data analysis: describing and displaying univariate numeric data (dot plots, boxplots, histograms, mean, median, quartiles/percentiles, standard deviation, variance, IQR)	
Exploratory data analysis: describing and displaying bivariate numeric data (scatterplot, correlation)	
Statistical modeling (single mean model, multiple means model, regression model)	
Sampling distributions: population vs sample, parameter vs statistic; distribution of sample mean, proportion; standard error	
Estimation: Confidence intervals, confidence interval for mean (using z), confidence interval for mean using t	
Estimation: confidence interval for difference in mean, confidence intervals for proportion	
Estimation: required sample size, confidence interval vs prediction interval	
Theory of estimation: unbiased estimators, maximum likelihood estimators	
Hypothesis testing: concepts and terminology, testing a single mean (z and t)	
Hypothesis testing: errors, power, 2-sample test, paired test, testing proportion	

Hypothesis testing: Non-parametric tests for 2 samples	
Comparing multiple means: one-way ANOVA	
Theory of ANOVA	
Regression: least squares method	
Partitioning of variability in regression, significance testing in regression	
Chi-squared test for independence	
Chi-squared goodness-of-fit	

GE 251 BIO (T)	**2 Credit**
Transmission Genetics	**No. of Lectures**
Genetic variation and behaviour of genes	6
Linkage and recombination; Mapping genes	
Chromosome maps and genetic markers	
Sex linkage and sex determination	
Complementation	
Chromosomal mutations	
Non-Mendelian inheritance	
Extrachromosomal DNA	
Quantitative genetics	
Population Genetics	**No. of Lectures**
Genetic variation in populations	6
Mutation and Genetic drift	
Natural selection	
Mutation/Selection balance	
Balanced polymorphism	
Gene flow & inbreeding	
Population Biology	**No. of Lectures**
Nature of populations; numbers, mixing (dispersal), structure in age/stage	4
Density independent, density dependent growth (exponential and logistic growth equations)	

R & K selection, life-histories and links to population growth parameters, (annual vs perennial life-histories, clonality)	
Demography, Life tables, matrix models (requires simple matrix mathematics) and Epidemiology (simple functions)	
Communities	**No. of Lectures**
Nature of communities; Community structure: how it is described, measured; what drives it; species composition, diversity (alpha, beta, gamma)	4
Intra-community (interspecific) interactions (bi-partite networks); Symbiosis, Predation, Competition, Host-parasite interactions	
Dynamics of communities (perturbation and succession)	
Biomes (communities on a global scale)	
Ecosystems	**No. of Lectures**
Pond ecosystem (or other integrated example)	4
Food chains and webs	
Pyramids (numbers, biomass, energy), abstraction, defining trophic levels, the problem of omnivore (stable isotope tracers)	
Biogeochemical cycles (water, C, N, P) pools and fluxes, mass budget models. Rates of processes: productivity, decomposition, trophic transfer, turnover and Mean Residence Time.	

PHY 281 FP (Any 2)	**2 Credit**
Field Project in Physics	**No. of Lectures**
Study of Fluid Dynamics in Natural Environments: Investigate fluid dynamics phenomena such as river flow, ocean currents, or atmospheric phenomena like wind patterns. This could involve field measurements, mathematical modeling, and data analysis.	12
Astronomy Observation: Set up telescopes in a dark-sky location to observe celestial objects such as planets, stars, and galaxies. Record observations of celestial phenomena such as eclipses, planetary transits, or meteor showers.	12

Study of Magnetic Fields: Explore magnetic fields in different environments, such as urban areas, near power lines, or in natural settings. Measure magnetic field strength and map out magnetic field lines using appropriate instruments.	12
Quantum Mechanics in Nature: Investigate phenomena that demonstrate quantum mechanical principles in nature, such as the behavior of particles in double-slit experiments, or the quantum properties of atoms and molecules in biological systems.	12

AEC 251 PS	**2 Credit**
Formal Presentation Skills	**No. of Lectures**
Presentation Types and Forms Theme based presentations Purpose based presentations- informative, persuasive, demonstrative, entertaining Form based presentation- Collage making.	6
News Presentation Understanding facts, focusing on gestures, controlled pace and pitch. Topic and Illustration Based Presentation Picture and non-verbal presentation	6
Presentation on an Article Presentation on an article for a magazine on trending issues Presentation based on illustration: Poster presentation	6
Presentation- Applications Presentation: based on the current reading material E-Portfolio: developing a self-presentation	6