SYLLABUS

PHYSICS

Unit I Mechanics

1. Fundamental physical quantities, unit and dimensions, vectors addition and subtraction, scalar and vector products of two vectors.
2. **Kinematics:** velocity and speed, acceleration – velocity – time graph; equation of motion with uniform acceleration; projectile motion. Newton's laws of motion, principle of conservation of linear momentum, work done by constant and variable force, energy and power, potential and kinetic energy, conservative and non-conservative forces, conservation of energy, renewable and non-renewable sources of energy, elastic and inelastic collision.
3. **Circular motion:** centripetal force, centrifugal force and its applications.
4. **Gravitation:** Newton's laws of gravitation, variation of acceleration due to gravity, gravitational field intensity, gravitational potential, potential energy in a gravitational field, geostationary satellites, orbital velocity, parking orbits, potential and kinetic energy of satellites, escape velocity.
5. **Rotational motion:** Kinetic energy due to rotational motion, torque and couple, work done by a torque, moment of inertia, angular momentum and its conservation, K.E. of a rolling object.
6. **Simple Harmonic Motion:** Simple pendulum, oscillating system, spring and mass, P.E. and K.E. in oscillating systems.
7. **Elasticity:** molecular theory, stress, strain, Hook's law, Young's, shear and bulk modulii, energy stored in a stretched wire, force in a bar due to contraction or expansion.
8. **Surface tension:** molecular theory of surface tension, surface energy, excess pressure inside a spherical liquid surface, angle of contact and capillary action.
9. **Viscosity:** Streamline and turbulent flows, velocity gradient, Newton's formula, coefficient of viscosity, Poiseuille's formula, Stoke's law, methods of determination of coefficient of viscosity.

Unit II Heat and Thermodynamics

1. **Heat and temperature:** thermal equilibrium, heat capacity, principle of calorimetry, cooling laws, latent heat, thermal

expansion of solid, liquid and gas, thermal stress, barometric correction, absolute temperature, kinetic theory of gasses, ideal gas equation.

2. **Transmission of heat:** conduction, temperature gradient, conductivity, convection, radiation, black body, Wien's displacement law, Stefan's law, Kirchhoff's law.
3. **Hygrometry:** relative and absolute humidity, phase diagram and triple point.
4. **Thermodynamics:** heat and work, internal energy, first law of thermodynamics, heat capacities of a gas, isothermal, isobaric, isochoric and adiabatic processes, second law of thermodynamics, Carnot's cycles, entropy.

Unit III Waves and Optics

1. **Reflection at plane and curved surfaces:** refraction at plane surfaces, refractive indices, lateral shift, critical angle, total internal reflection and its applications including optical fiber, refraction through prism, converging and diverging lenses, lens maker's formula and combination of lenses, defects of vision, correcting lenses.
2. **Dispersion of light:** white light spectrum, dispersive power, chromatic aberration, achromatic combination of lenses, optical instrument: spectrometer, visual angle, angular magnification, simple and compound microscope, prism binoculars, astronomical and terrestrial telescopes.
3. **Photometry:** luminous flux, luminous intensity, illuminance, Lambert's cosine law and photometers.
4. **Wave motion:** free, damped and forced oscillation, resonance, longitudinal and transverse wave motion, Progressive wave: velocity of transverse wave in a stretched string, velocity of a longitudinal wave in a fluid, velocity of sound in air, Laplace's correction, effect of temperature, pressure and humidity on the velocity of sound, principle of superposition; stationary waves, waves in pipes, strings and rods, intensity and intensity level, loudness, pitch and quality, noise pollution; beats, Doppler's effect. electromagnetic waves: electromagnetic spectrum, Huygen's wave theory, reflection and refraction of light wave, interference of light, coherent sources, optical path difference, phase difference, constructive and destructive interference, Young's double slits experiment; diffraction of light; Fresnel and Fraunhoffer diffraction, Single slit Fraunhoffer diffraction, polarization of light; Malus' law, Brewster's law and Polariod.

Unit IV Electricity and Magnetism

1. **Electrostatics:** electrostatic field: Coulomb's law, electric field, electric flux, Gauss's theorem, potential energy, electric potential, potential gradient, action of points, Van de Graaf's generator, capacitors, combination of capacitors, action of dielectric, relative permittivity and dielectric strength, energy of a charged capacitor, charging and discharging of capacitors.
2. **Electric current:** metallic conduction, potential difference, Ohm's law, Ohmic and non-ohmic conductors, resistance: resistivity, combination of resistors, Kirchhoff's laws and its application, heating effect of electric current, Joule's laws, thermoelectric effect, thermocouple, chemical effect of electric current, electrolysis, Faraday's laws.
3. **Magnetic field:** lines of forces, magnetic field due to current, Biot Savart law, Helmholtz coils, magnetic moment of a current loop, Ampere's theorem, force on conductor: force on moving charges, Hall effect, magnetic materials, magnetization, susceptibility, permeability, domain theory, hysteresis, dia, para and ferro-magnetism.
4. **Electromagnetic induction:** self induction, mutual induction, energy stored in magnetic filed of a coil. A.C. and D.C. generator, RMS value and peak value of the A.C. current; A.C. through L, R and C in series; power in A.C. circuit; transformer.

Unit V Modern Physics

1. **Electron:** Millikan's oil drop experiment, gaseous discharge, cathode rays; motion of electron in electric field and magnetic field, thermionic emission of electrons, specific charge of electron (e/m), cathode ray oscilloscope, photons: photoelectric effect.
2. **Atoms:** Bohrs theory of H-atom; energy levels; excitation and ionization energies; production of laser; its properties and uses, production of X-rays; properties and uses of X-rays; de Broglie's wave. Nucleus: atomic number; mass number and isotopes; mass energy relation; mass defect and binding energy. Radioactivity: properties of alpha, beta and gamma rays, G.M. tube; absorption of beta particles and gamma rays; laws of radioactive disintegration; half-life and mean-life; artificial disintegration; nuclear reaction; nuclear fission and fusion; radio isotopes; radiation hazards and safety measures.
3. **Electronics:** conductor, semiconductor and insulator, junction diode, rectifier, transistor, CE amplifier.

CHEMISTRY

Unit I General and Physical Chemistry

1. Language of Chemistry

Symbols and formulae, atoms and molecules, elements and compounds.

2. States of Matter

Molecular interpretation of three states of matter

Gaseous state: Gas laws: Boyle's Law; Charles' Law, Kelvin scale of temperature; universal gas constant; Dalton's Law of partial pressure, Graham's law of diffusion, kinetic theory of gases (no derivation), deviation of real gas from ideal behaviour, calculations involving gas laws.

Liquid state: properties of liquids, solution, concentration of solution, concept of molarity, solubility, effect of temperature on solubility, solubility curve, viscosity and surface tension.

Solid sate: Properties of solids, classification of solids based on different binding forces, crystals, crystal lattice, seven types of crystal system.

3. Laws of Stoichiometry and Avogadro's Hypothesis

Laws of stoichiometry: Law of conservation of mass, law of constant proportions, law of multiple proportions, law of reciprocal proportions, Gay Lussac's law of gaseous volumes, chemical calculations based on stoichiometry. Atomic and molecular masses, empirical and molecular formulae, Avogadro's hypothesis, important deductions form Avogadro's hypothesis, Avogadro's number, mole concept, determination of chemical formulae from percent composition, problems based on chemical equations.

4. Atomic Structure

The subatomic particles, the electrons and nucleons (protons and neutrons), their masses and charges, the atomic mass unit, Dalton's atomic theory, Rutherford's experiment, Bohr's model, interpretation of hydrogen spectra on the basis of Bohr's model, elementary idea of quantum mechanical model of atom, de Broglie relation, Heisenberg uncertainty principle, quantum numbers, atomic orbital, shapes of s and p orbitals, Pauli's exclusion principle, Hund's rule of maximum multiplicity; Aufbau principle, quantum designation of electrons, electronic configuration of atoms in the ground state up to Z = 30, Isotopes and fractional atomic weights, nuclear fission and fusion, radioactive disintegration and half life.

5. Chemical Bonding

Valency, octet rule, chemical bonds and Lewis structure, ionic bonds, covalent bond, electronegativity and ionic character of covalent bond, coordinate covalent bond, idea of metallic bonds, intermolecular forces, van der Waal's forces, hydrogen bonding, importance of hydrogen bonding, VSEPR theory and shapes of BeF_2, BF_3, CH_4, H_2O, NH_3, PF_5, and SF_6,

6. Oxidation and Reduction

Electronic concept of oxidation and reduction reactions, oxidation number, balancing redox reactions by oxidation number and ion–electron methods.

7. Periodic Table

Mendeleev's periodic table, modern periodic law and long form of periodic table, types of elements on the basis of periodic table, periodic trends in ionization energy, electron affinity, atomic radii, electronegativity and valency.

8. Acids, Bases and Salts

Classical definition, Arrhenius concept of acids, bases and salts, Bronsted-Lowry concept, Lewis concept, hydrogen ion concentration and pH, calculation of pH of strong acids, neutralization, hydrolysis of salts.

9. Volumetric Analysis

Equivalent weight of elements and compounds (acids, bases and salts), standard solution, primary and secondary standards, different ways of expressing concentration of solution, normality equation, titration based on neutralization and redox reactions, indicator, titration curve and selection of acid base indicator, solving problems on acidimetry and alkalimetry involving normality and molarity.

10. Electrochemistry

Electrolytic and metallic conduction, Arrhenius theory of ionization, Faraday's laws of electrolysis, electronic interpretation of Faraday's laws, mechanism of electrolysis and criteria of product formation, electrode potential, standard electrode potential, EMF of a galvanic cell and the use of electrode potential to predict a chemical reaction, commercial batteries.

11. Chemical Kinetics

Rate of reaction, rate law and rate constant, order and molecularity, half life period, factors affecting the rate of reaction (particle size, concentration, temperature, and catalyst), concept of activation energy, and idea of photochemical reaction.

12. Chemical Equilibrium

Equilibrium in physical processes, features of dynamic equilibrium, equilibrium constant, K_p and K_c, relation between K_p and K_c, LeChatelier's principle: effect of pressure, concentration, temperature and catalyst on chemical equilibrium, equilibrium involving ions, ionization of weak electrolytes (Ostwald's dilution law), degree of ionization and ionization constant, solubility and solubility product, common ion effect and their applications.

13. Chemical Thermodynamics

Language of thermo-chemistry, standard heats of formation and combustion, heat of neutralization, Hess's law, energy changes in chemical reactions, spontaneous processes, second law of thermodynamics, entropy and its physical concept, entropy and criteria of spontaneity in terms of entropy changes of universe, entropy changes in phase transformations, Gibb's free energy and the direction of chemical change, standard free energy change and equilibrium constant, free energy and useful work.

Unit II Inorganic Chemistry

1. Non-metals

Hydrogen: Unique position in periodic table, isotopes, preparation, properties and uses.

Oxygen and ozone: Preparation, properties and uses of oxygen, classification of oxides, preparation, properties and uses of ozone, structure of ozone, hole in the ozone layer.

Water: Structure of water, solvent properties of water, hard and soft water, detergents and water pollution, heavy water.

Carbon: Allotropes of carbon including fullerene, preparation, properties and uses of CO and CO_2, poisoning by CO.

Nitrogen: Nitrogen cycle, preparation, properties and uses of nitrogen, preparation, properties and uses of ammonia, principle of manufacture of ammonia by Haber process, structure of ammonia, principle of manufacture of nitric acid by Ostwald process, properties and structure of and uses of nitric acid, structure of oxides of nitrogen.

Sulphur: Allotropes of sulphur, preparation, properties and uses of H_2S, SO_2, principle of manufacture of sulphuric acid by contact process, properties and uses of sulphuric acid, sulphur dioxide and air pollution, acid rain.

Phosphorus: Allotropes of phosphorus, phosphine and phosphate fertilizer.

Halogen and halogen acids: Preparation, properties and uses, comparative study of HCl, HBr and HI, test of halides and tincture of iodine

Noble gases: Introduction, isolation and uses of noble gases, compounds of xenon-xenon fluorides.

2. Metals

Metals and metallurgy: Introduction, distinction between metals and non-metals, metalloid, electrochemical series and occurrence of metal, metallurgical principle and metallurgical terms.

Alkali and alkaline earth metals: Periodic discussion, general characteristics of alkali and alkaline earth metals, principle of extraction of sodium (Down's process), properties and uses of sodium, principle of manufacture of sodium carbonate, sodium hydroxide, and their properties and uses, biological importance of sodium and potassium, preparation, properties and uses of quicklime, plaster of Paris and bleaching powder, chemistry of magnesium hydroxide and Epsom salt.

*Coinage metals***:** Introduction, occurrence, extraction and properties of copper, chemistry of compounds of copper and silver (CuO, Cu_2O, $CuSO_4$. $5H_2O$, $AgNO_3$, and AgCl), purity of gold (carats and fineness)

Heavy metals: (zinc, iron, mercury and lead): Occurrence, extraction and properties of zinc, iron and mercury, manufacture of steel, heat treatment of steel, stainless steel, rusting of iron, galvanization, chemistry of compounds of iron, zinc and mercury and lead ($FeCl_3$, $FeCl_3 6H_2O$, $FeSO_4$. $7H_2O$, ZnO, ZnO, $ZnSO_4.7$ H_2O, Hg_2Cl_2, $HgCl_2$ PbO, and Pb_3O_4), Mercury pollution and mercury poisoning.

Unit III Organic Chemistry

1. Organic Chemistry: some basic principles

Introduction: Definition, sources and importance of organic compounds, detection of N, S and halogens in organic compounds.

Bonding in organic compounds: Tetracovalency of carbon, hybridization (sp, sp^2, sp^3), sigma and pi-bonds

Electronic displacement in covalent bond: inductive effect, electromeric effect, mesomeric effect and resonance

Fission in covalent bond: Homolytic and heterolytic fission, electrophiles and nucleophiles, carbocation and carbanions.

Formula of organic compounds: Empirical, molecular and structural, functional groups, homologous series, isomerism (structural & stereoisomerism), nomenclature of organic compounds.

2. Hydrocarbons

Classification of hydrocarbons, sources of hydrocarbons, nomenclature.

Alkanes: Nomenclature,preparation, proprties and uses of alkanes, octane number, preparation and properties of methane.

Alkenes: Nomenclature,preparation, proprties and uses of alkenes, Markovnikov's rule and peroxide effect, preparation, properties and uses of ethene.

Alkynes: Preparation, proprties and uses of ethyne, acidic nature of ethyne.

3. Organic halogen compounds

Alkyl halides: Nomenclature, nature of C–X bond, properties and uses of alkyl halides.

Chloroform: Prepation, properties, and uses.

4. Alcohols

Classification, nomenclature, distinction between 1°, 2° and 3° alcohols, industrial preparation of ethanol (hydration of ethene and fermentation) properties of alcohols.

5. Ethers

Nomenclature, important methods of preparation of diethyl ether, chemical and physical properties and uses of diethyl ether.

6. Carbonyl Compounds

Structures and nomenclature, preparation, properties and uses of formaldehyde, acetaldehyde and acetone, aldol condensation, Cannizzaro reaction

7. Carboxylic Acids

Structures and nomenclature, preparation, properties and uses of formic and acetic acid, derivatives of carboxylic acid: acid chlorides, acid anhydrides, ester and amides

8. Amines

Structures, classification, nomenclature, distinction and separation of primary, secondary and tertiary amines, chemical and physical properties and uses of ethylamine.

9. Aromatic Hydrocarbons

Benzene: Structure of benzene, nomenclature and structure of substituted benzene, properties and uses of benzene.

Aniline: Preparation, properties and uses.

Nitrobenzene: Preparation, properties and uses.

Phenol: Preparation, properties and uses.

10. Carbohydrates, Proteins, Nucleic Acids, and Lipids

Carbohydrates: Classification of carbohydrates, structures of glucoses and fructose, functions of carbohydrates.

Protein: Amino acids and peptide bonds, classification of proteins, denaturation and hydrolysis of protein, functions of proteins.

Nucleic acids: Types and constituents of nucleic acids, functions of nucleic acids.

Lipids: Lipids and triglycerides, phospholipids.

11. Polymers, Pesticides, Dyes and Drugs

Polymers: Polymerization (addition and condensation), classification of polymers, and some important synthetic polymers (polyethylene, PVC, polystyrene, Teflon, polyester, Terylene (Dacron), nylon 66

Pesticides: Introduction, DDT, Malathion and pheromones

Dyes: Classification of dyes with examples (based on chemical constitution and mode of application)

Drugs: General introduction to drugs: Antiseptic, analgesic, antipyretic, antacids, and tranquilizers.

BOTANY

Unit I Structure, Reproduction and Economic Importance of

Bacteria, Viruses and Lichens.

Unit II Structure, Reproduction and Economic Importance of

1. Algae: Nostoc and Spirogyra
2. Fungi: Mucor and Agaricus
3. Bryophyta: Marchantia and Funaria
4. Pteridophyta: Fern (Pteridium)
5. Gymnosperm: Pinus and Cycas

Unit III Plant Morphology

1. Part of a typical flowering plant (Mustard)
2. **Leaf:** morphology and modification
3. **Root:** Regions of root, Types and Modification
4. **Stem:** Types and Modification
5. Flower: parts
6. Fruits: Types
7. **Seeds:** Dicot, Monocot

Unit IV Taxonomy of Angiosperms

1. Basic concept of taxonomy and binominal nomenclature

2. Characteristics and Economic importance of the following families:
   Cruciferae, Solanaceae, Gramineae and Liliaceae

Unit V Plant Anatomy

Types of tissues, Primary internal structure of root, stem and leaf of monocot and dicot, Secondary growth of dioct stem.

Unit VI Plant Physiology

1. Water relations (diffusion, osmosis, absorption, transpiration and ascent of sap).
2. Photosynthesis
3. Respiration
4. Growth hormones.

Unit VII Cell Biology

1. Cell as a unit of life, structure of prokaryotic and eukaryotic cell, cell organelles and their function.
2. Biochemically important molecules (carbohydrates, proteins, amino acids, nucleic acid and lipids)
3. Cell divisions (Mitosis, meiosis and their significance)

Unit VIII Genetics

1. Mendelism, Mendel's Laws of Inheritance
2. Concept of incomplete dominance and co-dominance
3. Genetic materials (RNA and DNA), gene pool, crossing over, sex linked inheritance and mutation.

Unit IX Developmental Biology

1. Reproduction and development in angiosperms
2. Vegetative propagations
3. Micro and mega-sporogenesis, micro and mega-gametogenesis
4. Pollination, fertilization and development of dicot and monocot embryo.

Unit X Ecology and Biodiversity Conservation

1. Plant adaptation (hydrophytes, mesophytes and xerophytes)
2. Types of forests in Nepal
3. Biodiversity conservation, endangered species of plants and wildlife, causes of extinction.
4. Abiotic and biotic factors, food chain, food web, trophic level, pond and grassland ecosystems.
5. Ecological imbalances and its consequences:

a. Green house effect
b. Depletion of ozone layer

c. Acid rain
d. Pollution: Air, water, soil, their sources of pollution, effects and control measures.

Unit XI Application of Biology

1. Introduction to biotechnology
2. Principles of plant and animal breeding
3. Biofertilizers
4. Antibiotics, Vaccines
5. Tissue and Organ transplantation
6. Test tube baby
7. Fermentation
8. Genetic engineering and tissue culture

ZOOLOGY

Unit I Introduction

1. Scope and branches of biology, its relation with other subjects
2. Life and its origin, Oparin and Halden's theory, Miller Urcy Experiments.
3. Life components (Organic and inorganic)

Unit II Animal Diversity and Their Classification

1. General Characteristics and its classification up to class with examples of the following.
2. Protozoa, Porifera, Coelenterata, Platy-helminthes, Aschelminthes, Annelida, Arthropoda, Mollusca, Echinodermata and Chordata.

Unit III Biology of the following

1. Plasmodium vivax: Habit and habitat, structure (Sporozoite), life-cycle and control of malaria.
2. Paramecium caudatum: Habit and habitat, structure, reproduction (Binary fission and Conjugation with its significance).
3. Pheretima posthuma: Habit and habitat, structure, digestive, nervous and reproductive system and economic importance of earthworms.
4. Rana tigrina: Habit and habitat, structure, digestive, nervous, respiratory, circulatory, excretory, and reproductive system. Histology of the related organs.
5. Mammal (Rabbit / Man): Skin, respiratory, digestive, nervous, circulatory, excretory, and reproductive systems. Histology of the related organs, human blood groups and sense organs (Eye and Ear).

Unit IV Human Diseases

1. Socially significant: Drug abuse, Alcoholism and Smoking.
2. Communicable: Typhoid, Tuberculosis, Ascariasis, Giardiasis and AIDS.
3. Non-communicable: Cancer.

Unit V Rabbit Bones

Appendicular and Axial

Unit VI Endocrinology of Mammal

Pituitary, thyroid and parathyroid, adrenal, islets of langerhans.

Unit VII Animal Tissues

Epithelial, Connective, Muscular and Nervous.

Unit VIII Animal Behavior

1. Reflex action
2. Taxes
3. Leadership
4. Migration of fishes and birds: Habit and habitat, structure, digestive, nervous and reproductive.

Unit IX Animal Adaptation

1. Aquatic
2. Amphibians
3. Terrestrial
4. Volant (aerial)
5. Desert and parasitic

Unit X Evolution

1. Definition, Organic evolution
2. History, theories of organic evolution (Lamarckism, Darwinism, Neo-Darwinism)
3. Evidences of organic evolution (morphological, embryological, anatomi-cal, paleontological, chemical and genetic)
4. Human evolution

Unit XI Developmental Biology

Development of frog (embryonic and post embryonic development)