

# SYLLABUS FOR AEEL 2024

## PHYSICS

### Unit 1: Units and dimensions

Units for measurement, system of units, SI, fundamental and derived units, dimensional analysis.

### Unit 2: Kinematics:

Uniform and non-uniform motion, average speed and instantaneous velocity, uniformly accelerated motion, velocity-time, position-time graph, relations for uniformly accelerated motion, Scalars and Vectors, Vector. Addition and subtraction, zero vector, scalar and vector products, Unit Vector, Resolution of a Vector. Relative Velocity, Motion in a plane, Projectile Motion, Uniform Circular Motion.

### Unit 3: Mechanics

Motion in one-dimension, uniform and non-uniform motion, uniformly accelerated motion; Scalars and Vectors, resolution of Vectors, vector properties. Motion in a plane, Projectile motion, Uniform circular motion.

Newton's laws of motion, conservation of linear momentum, Friction; Work-Energy theorem, kinetic energy, potential energy, conservation of energy; elastic collision in one and two dimensions.

Center of mass of a system of particles, centre of mass of a rigid body, rotational motion and torque, angular momentum and its conservation, moments of inertia for various geometries, parallel and perpendicular axes theorem.

Universal law of gravitation, acceleration due to gravity, planetary motion, Kepler's laws, Satellites, gravitational potential and potential energy and escape velocity.

### Unit 4: Solids and Fluids

**Solids:** Elastic properties, Hooke's law, Young's modulus, bulk modulus, rigidity modulus.

**Liquids:** Cohesion and adhesion; surface energy and surface tension; flow of fluids; Bernouli's theorem and applications; viscosity, Stoke's law, terminal velocity

### Unit 5: Oscillations and Waves

**Oscillations:** Oscillatory motion - periodic and non-periodic motion; simple harmonic motion (SHM), angular SHM, linear harmonic oscillator – both horizontal and vertical; combination of springs – series and parallel, simple pendulum; Expression of energy – potential energy, kinetic energy and total energy; Graphical representation of SHM; Types of oscillations – free, damped, maintained and forced oscillations and resonance.

**Wave Motion:** Properties of waves; Transverse and Longitudinal waves; Superposition of waves, Progressive and Standing waves; Vibration of strings and air columns, beats, Doppler Effect.

### Unit 6: Electrostatics, Current Electricity and Magnetostatics

**Electric charges and Fields:** Electric Charge; Conductors and Insulators, Charging by Induction, Basic Properties of Electric Charge, Coulomb's Law, Forces between Multiple Charges, Electric Field, Electric Field Lines, Electric Flux, Electric Dipole, Dipole in a Uniform External Field, Continuous Charge Distribution, Gauss's Law, Applications of Gauss's Law.

**Electrostatic potential and Capacitance:** Electrostatic potential, Potential due to a point charge, electric dipole, system of charges. Equipotential surfaces; Potential energy of a system of charges, potential energy in an external field, Electrostatics of conductors, Dielectric and Polarization, Capacitors and Capacitance, parallel plate capacitor, effect of dielectric on capacitance combination of capacitors, energy stored in a capacitor, Van de Graaff Generator.

**Current Electricity:** Electric current, electric currents in conductors, Ohm's law, drift of electrons and the origin of Resistivity, temperature dependence of resistivity, electrical energy, power, combination of resistors, series and parallel, cells, emf, internal resistance, cells in series and in parallel, Kirchhoff's Rules, Wheatstone bridge, Meter bridge, potentiometer.

**Heating effects of current:** Electric power; concept of thermoelectricity – Seebeck effect and thermocouple, chemical effect of current – Faraday's laws of electrolysis.

**Magnetic effects:** Oersted's experiment, BiotSavart's law, magnetic field due to a straight wire, circular loop and solenoid, force on a moving charge in a uniform magnetic field (Lorentz force), forces and torques on a current carrying conductor in a magnetic field, force between current carrying wires, moving coil galvanometer and conversion to ammeter and voltmeter.

**Magnetostatics:** Bar magnet, magnetic field, lines of force, torque on a bar magnet in a magnetic field, earth's magnetic field; para, dia, and ferro magnetism, magnetic induction and magnetic susceptibility.

### **Unit 7: Electromagnetic Induction and Electromagnetic Waves**

**Electromagnetic Induction:** Induced e. m. f: Magnetic flux, Faraday's law, Lenz's Law and Conservation of Energy, self and mutual inductance.

**Alternating Current:** Impedance and reactance; power in AC circuits; AC voltage applied to resistor, inductor, capacitor, LCR circuits and resonance, transformer and AC generator.

**Electromagnetic Waves:** Electromagnetic waves characteristics, electromagnetic spectrum from gamma to radio waves.

**Unit 8: Kinetic Theory of Gases:** Equation of state of a perfect gas, work done on compressing a gas, Kinetic theory of gases - assumptions, the concept of pressure. Kinetic energy and temperature: RMS speed of gas molecules: Degrees of freedom. Law of equipartition of energy, applications to specific heat capacities of gases; Mean free path. Avogadro's number.

### **Unit 9: Ray and Wave Optics**

**Ray Optics and optical instruments:** Reflection and refraction of light by plain spherical mirrors - Total Internal Reflection; optical fiber; deviation and dispersion of light by a prism; lens formula; magnification and resolving power; microscope and telescope.

**Wave Optics:** Huygens principle: Wave nature of light, interference of light waves and Young's experiment, thin films, Newton's rings, Diffraction – single slit, grating, Polarization and applications.

### **Unit 10: Modern Physics**

**Dual nature of radiation and matter:** De Broglie relation, Electron emission, photoelectric effect, experimental study, Einstein's photoelectric equation: Energy quantum of radiation; particle nature of light, the photon, wave nature of matter.

**Atoms:** Alpha-particle scattering and Rutherford's nuclear model of atom, atomic spectra, Bohr model of the hydrogen atom; the line spectra of the hydrogen atom.

**Nuclei:** Atomic masses and composition of nucleus; size of the nucleus; mass-energy and nuclear binding energy; nuclear force; radioactivity; nuclear energy

**Semiconductor materials, devices and simple circuits:** Energy bands in solids; classification of metals, conductors and semiconductors; intrinsic semiconductor, extrinsic semiconductor, p-n junction, semiconductor diode, junction diode as a rectifier, junction transistor, transistor as an amplifier.

# CHEMISTRY

**Unit 1 – Basic Chemical calculations:** Density - mole concept - empirical and molecular formula – stoichiometry - volumetry, equivalent and molecular masses, percentage composition

**Unit 2 - Atomic structure & periodicity:** Atomic models, sub-atomic particles, orbital shapes, Pauli's exclusion, Hund's rule, Aufbau principle, de-Broglie relation, Heisenberg's uncertainty, electronic configuration and periodic properties.

**Unit 3 - Chemical bonding:** Ionic bonding, lattice energy – Born-haber cycle, covalent bond - Fajan's Rule –VSEPR theory - hybridization, valence bond and molecular orbital theory, coordinate, metallic and hydrogen bonding

**Unit 4 - d and f block elements:** d-block elements configuration and properties - transition elements, chromium, copper, zinc, silver, interstitial compounds and alloys, f - block elements and extraction, lanthanides and actinides

**Unit 5 - Solid state:** Solids - amorphous and crystalline, classification of crystalline - unit cell, Miller indices - packing efficiency, unit cell dimensions, crystal structure, ionic crystals, imperfections in solids, electric and magnetic properties.

**Unit 6 - Coordination compounds:** Terminology in coordination- isomerism, Werner, VBT, CFT theories - Bio-coordination compounds.

**Unit 7 - Gaseous State & Surface chemistry:** Gaseous state and gas laws, deviation- van der Waal's constants - Joule-Thomson effect - liquefaction of gases, theory of catalysis, colloids and emulsions.

**Unit 8 - Colligative properties:** Lowering of vapour pressure, Depression of freezing point, Elevation in boiling point, Osmotic pressure, abnormality - dissociation and association

**Unit 9 – Electrochemistry:** Faraday's laws - specific, equivalent and molar conductances, Kohlraush's law and applications- electrode potentials - EMF, electrochemical and, galvanic cells, Nernst equation, batteries, fuel cells, corrosion and its prevention.

**Unit 10 -Thermodynamics:** First and second law- internal energy, enthalpy, entropy, free energy changes– specific heats at constant pressure and constant volume – enthalpy of combustion, formation and neutralization, Kirchoff law – Hess's law - bond energy

**Unit 11 - Chemical and Ionic Equilibrium:** Law of chemical equilibrium, homogenous and heterogeneous equilibrium, Le Chatlier's principle, equilibrium constants, factors affecting- Ionic equilibrium, ionization of acids and bases, buffer solutions, pH -solubility of sparingly soluble salts

**Unit 12 - Chemical kinetics:** Order, molecularity, rate and rate constant – first and second order reactions - temperature dependence, factors influencing rate of reaction, integrated rate equation, collision theory of chemical reaction

**Unit 13 - Basic Organic chemistry:** Classification, functional groups, nomenclature and isomerism, types of organic reactions, mechanism, purification, qualitative and quantitative analysis carbocation, carbanion and free radical, electron displacement in covalent bond.

**Unit 14 - Hydrocarbons & Polymers:** IUPAC nomenclature, alkanes –alkynes – aromatic hydrocarbons- nomenclature, preparation, physical and chemical properties uses. Polymerization – types, molecular mass, biodegradable and commercial polymers.

**Unit 15 - Organic halogen compounds:** Nature of C-X bond- preparation - properties and reactions of alkyl and aryl halides- polyhalogen compounds - substitution and elimination – mechanism- Grignard reagents.

**Unit 16 - Stereochemistry and Organic nitrogen compounds:** Preparation - properties and uses of Aliphatic and aromatic nitro compounds --aliphatic and aromatic amines, nitriles, Diazonium salts. – 1°, 2°, and 3° amines – distinction - Optical activity.

**Unit 17 - Organic functional groups – hydroxyl, carbonyl compounds and ethers:** Nomenclature, preparation, properties and uses of alcohols, ethers, aldehydes, ketones, aliphatic carboxylic acids, benzoic acid - salicylic acid.

**Unit 18 - Biomolecules and Environmental chemistry:** Carbohydrates, proteins, amino acids - enzymes, vitamins, and nucleic acids - lipids. Pollution. - air, water and soil - industrial waste, acid rain, greenhouse effect, global warming, Strategies to control pollution.

## BIOLOGY

### Unit 1: Diversity of Living Organisms

**The Living World:** Biodiversity; Need for classification; three domains of life; taxonomy and systematics; concept of species and taxonomical hierarchy; binomial nomenclature.

**Biological Classification:** Five kingdom classification; Salient features and classification of Monera, Protista and Fungi into major groups; Lichens, Viruses and Viroids.

**Plant Kingdom:** Classification of plants into major groups; Salient and distinguishing features and a few examples of Algae, Bryophyta, Pteridophyta, Gymnospermae

**Animal Kingdom:** Salient features and classification of animals, non-chordates up to phyla level and chordates up to class level

### Unit 2: Structural Organization in Animals and Plant

**Morphology of Flowering Plants:** Morphology of different parts of flowering plants: root, stem, leaf, inflorescence, flower, fruit and seed. Description of family Solanaceae

**Anatomy of Flowering Plants:** Anatomy and functions of tissue systems in dicots and monocots.

**Structural Organisation in Animals:** Morphology, Anatomy and functions of different systems of frog.

### Unit 3: Cell Structure and Function

**Cell-The Unit of Life:** Cell theory and cell as the basic unit of life, structure of prokaryotic and eukaryotic cells; Plant cell and animal cell; cell envelope; cell membrane, cell wall; cell organelles - structure and function; endomembrane system, endoplasmic reticulum, golgi bodies, lysosomes, vacuoles, mitochondria, ribosomes, plastids, microbodies; cytoskeleton, cilia, flagella, centrioles (ultrastructure and function); nucleus.

**Biomolecules:** Chemical constituents of living cells: biomolecules, structure and function of proteins, carbohydrates, lipids, nucleic acids; Enzyme - types, properties, enzyme action.

**Cell Cycle and Cell Division:** Cell cycle, mitosis, meiosis and their significance

### Unit 4: Plant Physiology

**Photosynthesis in Higher Plants:** Photosynthesis as a means of autotrophic nutrition; site of photosynthesis, pigments involved in photosynthesis (elementary idea); photochemical and biosynthetic phases of photosynthesis; cyclic and non-cyclic photophosphorylation; chemiosmotic hypothesis; photorespiration; C<sub>3</sub> and C<sub>4</sub> pathways; factors affecting photosynthesis.

**Respiration in Plants:** Exchange of gases; cellular respiration - glycolysis, fermentation (anaerobic), TCA cycle and electron transport system (aerobic); energy relations - number of ATP molecules generated; amphibolic pathways; respiratory quotient.

**Plant - Growth and Development:** Seed germination; phases of plant growth and plant growth rate; conditions of growth; differentiation, dedifferentiation and redifferentiation; sequence of developmental processes in a plant cell; growth regulators - auxin, gibberellin, cytokinin, ethylene, ABA;

## Unit 5: Human Physiology

**Breathing and Exchange of Gases:** Respiratory organs in animals (recall only); Respiratory system in humans; mechanism of breathing and its regulation in humans - exchange of gases, transport of gases and regulation of respiration, respiratory volume; disorders related to respiration - asthma, emphysema, occupational respiratory disorders.

**Body Fluids and Circulation:** Composition of blood, blood groups, coagulation of blood; composition of lymph and its function; human circulatory system - Structure of human heart and blood vessels; cardiac cycle, cardiac output, ECG; double circulation; regulation of cardiac activity; disorders of circulatory system - hypertension, coronary artery disease, angina pectoris, heart failure.

**Excretory Products and their Elimination:** Modes of excretion - ammonotelism, ureotelism, uricotelism; human excretory system – structure and function; urine formation, osmoregulation; regulation of kidney function - renin - angiotensin, atrial natriuretic factor, ADH and diabetes insipidus; role of other organs in excretion; disorders - uremia, renal failure, renal calculi, nephritis; dialysis and artificial kidney, kidney transplant.

**Locomotion and Movement:** Types of movement - ciliary, flagellar, muscular; skeletal muscle, contractile proteins and muscle contraction; skeletal system and its functions; joints; disorders of muscular and skeletal systems - myasthenia gravis, tetany, muscular dystrophy, arthritis, osteoporosis, gout.

**Neural Control and Coordination:** Neuron and nerves; Nervous system in humans - central nervous system; peripheral nervous system and visceral nervous system; generation and conduction of nerve impulse

**Chemical Coordination and Integration:** Endocrine glands and hormones; human endocrine system - hypothalamus, pituitary, pineal, thyroid, parathyroid, adrenal, pancreas, gonads; mechanism of hormone action (elementary idea); role of hormones as messengers and regulators, hypo - and hyperactivity and related disorders; dwarfism, acromegaly, cretinism, goiter, exophthalmic goitre, diabetes, Addison's disease. Note: Diseases related to all the human physiological systems to be taught in brief.

## Unit 6: Reproduction

**Sexual Reproduction in Flowering Plants:** Flower structure; development of male and female gametophytes; pollination - types, agencies and examples; out breeding devices; pollen-pistil interaction; double fertilization; post fertilization events - development of endosperm and embryo, development of seed and formation of fruit; special modes - apomixis, parthenocarpy, polyembryony; Significance of seed dispersal and fruit formation.

**Human Reproduction:** Male and female reproductive systems; microscopic anatomy of testis and ovary; gametogenesis - spermatogenesis and oogenesis; menstrual cycle; fertilisation, embryo development upto blastocyst formation, implantation; pregnancy and placenta formation (elementary idea); parturition (elementary idea); lactation (elementary idea).

**Reproductive Health:** Need for reproductive health and prevention of Sexually Transmitted Diseases (STDs); birth control - need and methods, contraception and medical termination of pregnancy (MTP); amniocentesis; infertility and assisted reproductive technologies - IVF, ZIFT, GIFT (elementary idea for general awareness).

## Unit 7: Genetics and Evolution

**Heredity and variation:** Mendelian inheritance; deviations from Mendelism – incomplete dominance, co-dominance, multiple alleles and inheritance of blood groups, pleiotropy; elementary idea of polygenic inheritance; chromosome theory of inheritance; chromosomes and genes; Sex determination - in humans, birds and honey bee; linkage and crossing over; sex linked inheritance - haemophilia, colour blindness; Mendelian disorders in humans - thalassemia; chromosomal disorders in humans; Down's syndrome, Turner's and Klinefelter's syndromes.

**Molecular Basis of Inheritance:** Search for genetic material and DNA as genetic material; Structure of DNA and RNA; DNA packaging; DNA replication; Central Dogma; transcription, genetic code, translation; gene expression and regulation - lac operon; Genome, Human and rice genome projects; DNA fingerprinting.

**Evolution:** Origin of life; biological evolution and evidences for biological evolution (paleontology, comparative anatomy, embryology and molecular evidences); Darwin's contribution, modern synthetic theory of evolution; mechanism of evolution - variation (mutation and recombination) and natural selection with examples, types of natural selection; Gene flow and genetic drift; Hardy - Weinberg's principle; adaptive radiation; human evolution

### **Unit 8 Biology and Human Welfare:**

**Human Health and Diseases:** Pathogens; parasites causing human diseases (malaria, dengue, chikungunya, filariasis, ascariasis, typhoid, pneumonia, common cold, amoebiasis, ring worm) and their control; Basic concepts of immunology - vaccines; cancer, HIV and AIDS; Adolescence - drug and alcohol abuse.

**Microbes in Human Welfare:** Microbes in food processing, industrial production, sewage treatment, energy generation and microbes as bio-control agents and bio-fertilizers. Antibiotics; production and judicious use.

### **Unit 9: Biotechnology and its Applications**

**Biotechnology - Principles and Processes:** Genetic Engineering (Recombinant DNA Technology).

**Biotechnology and its Applications:** Application of biotechnology in health and agriculture: Human insulin and vaccine production, stem cell technology, gene therapy; genetically modified organisms - Bt crops; transgenic animals; biosafety issues, biopiracy and patents

### **Unit 10: Ecology and Environment**

**Organisms and Populations:** Population interactions - mutualism, competition, predation, parasitism; population attributes - growth, birth rate and death rate, age distribution. (Topics excluded: Organism and its Environment, Major Abiotic Factors, Responses to Abiotic Factors, Adaptations)

**Ecosystem:** Ecosystems Patterns, components; productivity and decomposition; energy flow; pyramids of number, biomass, energy (Topics excluded: Ecological Succession and Nutrient Cycles)

**Biodiversity and its Conservation:** Biodiversity-Concept, patterns, importance; loss of biodiversity; biodiversity conservation; hotspots, endangered organisms, extinction, Red Data Book, Sacred Groves, biosphere reserves, national parks, wildlife, sanctuaries and Ramsar sites.

## **ENGLISH**

Articles, Synonyms, Antonyms, Preposition, verbs.