PHYSICS SYLLABUS

1. Dimensional Analysis
Physical quantities, classification by origin (fundamental and derived quantities). Dimensions and the principle of homogeneity.

2. Vector Analysis I
Classification of physical quantities by nature (scalar and vector), properties, characteristics. Vector addition: polygon and parallelogram methods, sine and cosine laws, vector subtraction.

3. Vector Analysis II
Vector decomposition, rectangular components. Unit vectors, scalar product, vector product.

4. Kinematics I – Uniform Rectilinear Motion (URM)
Basic elements of mechanical motion. Average speed, average velocity, instantaneous velocity. Rectilinear motion (URM), vector and scalar equations. Special cases.

5. Kinematics II – Uniformly Accelerated Rectilinear Motion (UARM)
Average acceleration, instantaneous acceleration. Uniformly accelerated rectilinear motion (UARM), equations and special cases.

6. Kinematics III – Free Vertical Motion (FVM)
Free fall motion. Vertical free fall motion. Properties. Vector equations.

7. Kinematics IV – Two-Dimensional Motion (Parabolic Free Motion, PFM)
Two-dimensional motion. Motion with constant acceleration. Parabolic free motion (PFM). Properties and equations. Trajectory equation.

8. Kinematics V – Graph Analysis
Graphs of linear and quadratic functions. Graphs of URM and UARM.

9. Kinematics VI – Uniform Circular Motion (UCM)
Description of circular motion, distance traveled (S or L), linear or tangential velocity. Angular kinematic quantities: angular displacement (Δθ), average angular velocity (ω_avg), instantaneous angular velocity. Centripetal acceleration (α_cp). Uniform circular motion (UCM).

10. Kinematics VII – Uniformly Accelerated Circular Motion (UACM)

Average angular acceleration (α_avg), instantaneous angular acceleration (α). Uniformly accelerated circular motion (UACM), tangential acceleration (α_t). Total acceleration (a). Angular and tangential equations. Relative motion.

11. Statics I

Force. Newton's first law, Newton's third law. Free-body diagram. Equilibrium of a particle. Smooth and rough surfaces.

12. Statics II

Friction forces. Rigid body. Moment of a force. Equilibrium of a rigid body.

13. Dynamics I

Newton's second law. Dynamics of smooth and rough planar motion. Shortcut methods.

14. Dynamics II

Newton's second law. Smooth and rough planes. Shortcut methods. Circular dynamics. Inertial reference systems (IRS). Non-inertial reference systems (NIRS). Galilean transformations.

16. Universal Gravitation I

Kepler's laws. Law of universal gravitation. Variation of gravitational acceleration with height.

17. Universal Gravitation II

Satellite motion. Gravitational field. Gravitational field intensity. Gravitational potential energy. Gravitational potential.

18. Work and Kinetic Energy

Work done by a constant force, work done by a variable force. Net work. Energy, work-energy theorem.

19. Potential Energy – Work and Mechanical Energy Theorem

Potential energy. Conservative forces. Work and mechanical energy theorem.

20. Conservation of Mechanical Energy – Power
Mechanical power. Hydraulic power. Machine efficiency.

21. Impulse and Momentum
Linear momentum. Impulse, graphs. Impulse-momentum theorem. Principle of conservation of momentum. Center of mass.

22. Collisions
Collisions. One-dimensional collisions. Coefficient of restitution. Elastic collision. Inelastic collision. Plastic collision. Oblique collisions.

23. Oscillations I
Simple harmonic motion (SHM). Position, velocity, acceleration. Graphs of SHM equations. Important properties. Mass-spring system. Spring associations.

24. Oscillations II
Simple pendulum. Energy of SHM. Energy vs. position graphs. Energy vs. time graphs.

25. Mechanical Waves I
Wave classification. Transverse waves, longitudinal waves, graphs, speed, propagation speed of a disturbance. Dynamic analysis of a traveling wave on a taut string. Equation of a traveling sinusoidal wave. Equation of a traveling longitudinal wave.

26. Mechanical Waves II
Standing waves. Power and transmitted energy. Sound waves.

27. Mechanical Waves III
Physical phenomena in wave motion: pulse, refraction, diffraction, Huygens' principle, polarization, superposition, interference, standing waves, sound waves, Doppler effect.

28. Hydrostatics I
Density, specific weight, pressure. Hydrostatic pressure. Absolute pressure. Gauge pressure. Communicating vessels. Torricelli's experiment. Pascal's principle. Hydraulic press.

29. Hydrostatics II

Pascal's principle. Hydraulic press. Archimedes' principle.

30. Temperature and Heat I

Thermometric scales. Zeroth law of thermodynamics. Thermal equilibrium. Thermal expansion: linear, superficial, volumetric.

31. Temperature and Heat II

Heat. Heat transfer in temperature change. Equilibrium temperature of a mixture. Phase changes. Latent heat of fusion, solidification, condensation. Heat transfer.

32. Thermodynamics I

Preliminary concepts. Ideal gases. Ideal gas equation. Processes: isobaric, isochoric, isothermal, adiabatic. Universal ideal gas equation. Heat capacity of an ideal gas. Internal energy. Thermodynamic properties, state, and processes. First law for a closed system. Work calculation.

33. Thermodynamics II

Heat engine representation, efficiency. Refrigerator. Heat pump. Carnot cycle. Second law of thermodynamics.

34. Electrostatics I

Electric charge. Quantization of charge. Law of electric charges. Coulomb's law. Conductors and insulators. Methods of electrifying a body.

35. Electrostatics II

Electric field. Electric field intensity, representation. Lines of force, properties. Uniform electric field. Electric potential. Equipotential surfaces. Work done on a charged particle. Electric potential difference.

36. Electrostatics III

Characteristics of a conductor in electrostatic equilibrium. Capacitors.

37. Electric Current I

Electrical resistance. Pouillet's law. Ohm's law. Resistor associations: series and parallel. Short circuit. Symmetric connections.

38. Electric Current II

Wheatstone bridge. Delta-Star transformation. Y-Delta transformation. Sources of electrical energy. Electromotive force. Kirchhoff's laws.

39. Electric Current III

Electrical power, Joule effect, electrical measuring instruments.

40. Electromagnetism I

Magnetization, demagnetization. Magnetic field, uniform magnetic field. Earth's magnetic field. Electromagnetism. Biot-Savart law. Magnetic induction. Solenoid, toroid.

41. Electromagnetism II

Magnetic force on a moving charge. Lorentz force. Magnetic force on a straight conductor. Force between parallel conductors.

42. Electromagnetism III

Magnetic flux, Faraday's law, Lenz's law. Alternating current.

43. Electromagnetism IV

Transformer. Electromagnetic waves.

44. Optics I

Preliminary concepts. Corpuscular theory, wave theory, modern theory. Luminous and illuminated bodies. Reflection: regular and irregular. Mirrors, image formation. Number of images between two plane mirrors. Spherical mirrors.

45. Optics II

Refractive index. Laws of refraction. Total internal reflection. Effects of refraction: apparent elevation of submerged bodies, apparent depth, mirage. Dispersion of white light. Rainbow. Color of bodies.

46. Optics III

Converging lenses, diverging lenses. Lens elements. Image construction in a lens. Thin lens equations. Lensmaker's equation. Combination of thin lenses. Wave optics: diffraction, interference, polarization.

47. Modern Physics

Blackbody radiation. Theories of blackbody radiation. Planck's postulates. Quantization of electromagnetic energy. Photoelectric effect. X-rays. Laser.