Physics I. Outline

1. Mathematics
   (i) Calculus
      (a) Derivatives
      (b) Integral
      (c) Exponential function
   (ii) Vector
      (a) Dot product
      (b) Cross product

2. Applications of Newton’s laws
   (i) The dynamics of uniform circular motion
   (ii) Limitations of Newton’s law

3. Systems of particles
   (i) Two-particle systems
   (ii) Many-particles systems
   (iii) Center of mass
   (iv) Conservation of momentum
   (v) Systems of variable mass

4. Rotational kinematics
   (i) Rotational motion
   (ii) The rotational variables
   (iii) Rotational quantities
   (iv) Relationships between linear and angular variables

5. Rotational dynamics
   (i) Torque
   (ii) Rotational inertia
   (iii) Combined rotational and translational motion

6. Angular momentum
   (i) Angular momentum of a particle
   (ii) Angular momentum and angular velocity
   (iii) Conservation of angular momentum
   (iv) The spinning top

7. Work and kinetic energy
   (i) Work and energy
   (ii) Power
   (iii) Work done by a constant and variable force
   (iv) Kinetic energy and the work-energy theorem
   (v) Work and kinetic energy in rotational motion

8. Potential energy
   (i) Conservation forces
   (ii) Potential energy
   (iii) Conservation of mechanical energy
   (iv) Energy conservation in rotational motion

9. Conservation of energy
   (i) Work done on a system by external forces
   (ii) Conservation of energy
   (iii) Center of mass energy
   (iv) Reactions and decays

10. Gravitation
    (i) Newton’s law of universal gravitation
    (ii) The two shell theorem
    (iii) The motion of planets and satellites
11. Fluid
(i) Pressure and density
(ii) Variation of pressure in a fluid at rest
(iii) Pascal’s principle and Archimedes’ principle
(iv) Fluid flow
(v) Equation of continuity
(vi) Bernoulli’s equation
(vii) Fields of flow

12. Oscillations
(i) The simple harmonic motion (SHM)
(ii) Energy in SHM
(iii) SHM and uniform circular motion
(iv) Damped harmonic motion
(v) Two-body oscillations

13. Sound waves
(i) Properties of sound waves
(ii) Traveling sound waves
(iii) Power and intensity
(iv) Standing wave
(v) Vibrating system
(vi) The Doppler effect

14. The special relativity
(i) Troubles with classical physics
(ii) The postulates
(iii) The Lorentz transformation
(iv) Measuring the space-time coordinates
(v) Consequences of the Lorentz transformation
(vi) Relativistic momentum and energy

15. Temperature
(i) Temperature and thermal equilibrium
(ii) The ideal gas

16. Molecular properties of gases
(i) The atomic nature
(ii) The mean free path
(iii) The distribution of molecular speeds and energies
(iv) Equation of state

17. The first law of thermodynamics
(i) Heat
(ii) The first law of thermodynamics
(iii) Heat capacity and specific heat
(iv) Work done by an ideal gas
(v) The internal energy
(vi) Applications of first law

18. Entropy and the second law of thermodynamics
(i) One-way process
(ii) Defining entropy change
(iii) Irreversible processes
(iv) The second law of thermodynamics
(v) Entropy and performance of engine
(vi) A statistical view of entropy