

Physics Syllabus for BS / BSC / Masters / MPhil

Vectors

- Derivatives and integration of a vector
- The gradient of a scalar, divergence and curl of a vector
- physical significance of gradient of scalars
- divergence and curl of vectors, Green theorem
- divergence theorem (without proof)
- Stokes' theorem (without proof) and physical significance and applications

Force and Newton's Laws

- Review of motion in one-dimension
- classical mechanics
- Newton's first law, force
- mass, Newton's second law
- Newton's third law
- weight and mass
- applications of Newton's laws in one-dimension

Motion in Two and Three Dimensions

- Motion three dimensions with constant acceleration
- Newton's laws in three-dimensional vector form
- projectile motion, drag forces, and motion of projectiles
- uniform circular motion, relative motion

Applications of Newton's Law

- Force laws, frictional forces
- The dynamics of uniform circular motion
- equation of motion (constant and non-constant) forces
- Time-dependent forces, drag forces and the motion of projectiles
- limitations of Newton's laws

Momentum

- Collisions
- linear momentum
- impulse and momentum
- conservation of momentum
- two-body collisions

Systems of Particles

- Two-particle systems, many-particle systems
- center of mass of solid objects
- Linear momentum of a particle
- linear momentum of s system of particles
- conservation of linear
- work and energy in a system of particles
- systems of variable mass

Rotational Dynamics

- Review of rotational kinematics
- torque, rotational inertia, and Newton's law
- The rotational inertia of solid bodies
- The torque due to gravity
- equilibrium applications of Newton's law for rotation
- non-equilibrium applications of Newton's laws for rotation
- combined rotational and translational motion

Angular Momentum

- Angular momentum of a particle
- System of particles
- angular momentum and angular velocity
- conservation of angular momentum
- the spinning top

Work and Kinetic Energy

- Work and energy
- work done by constant forces
- power, work is done by a variable force in one- and two-dimensions
- kinetic energy and the work-energy theorem

Potential Energy

- Conservative forces
- potential energy
- conservation of mechanical energy
- one-dimensional conservative systems and complete solution
- Two- and threedimensional conservative systems

Conservative of Energy

- Work was done on a system by external forces
- the internal energy of particles, frictional work
- conservation of energy in a system of particles
- center-of-mass energy

Gravitational

- Gravitation from the ancients to Kepler
- Newton and law of universal gravitation
- the gravitational constant G , gravity near earth's surface
- the gravitational effect of a spherical distribution of matter
- gravitational potential energy, the gravitational field and potential, the motions of planets and satellites, universal gravitation

Special Relativity

- Troubles with classical physics
- the postulates of special relativity
- consequences of Einstein's postulates
- the Lorentz transformation
- measuring the space-time coordinates of an event

- the transformation of velocities
- consequences of the Lorentz transformation
- relativistic momentum, relativistic energy

The Electric field

- Review of electric charge and Coulomb's law
- fields, the electric field E
- the electric field of point charges
- lines of force, the electric field of continuous charge distribution, a point in an electric field, a dipole in an electric field

Gauss's Law

- The flux of a vector field, the flux of the electric field
- Gauss's law, a charged isolated conductor
- applications of Gauss's law
- experimental tests of Gauss's law and Coulomb's law

Electric Potential Energy and Potential

- Electrostatic and gravitational forces
- electric potential energy, electric potential
- calculating the potential due to point a charge
- potential due to collection of point charges
- the electric potential of continuous charge distributions
- equipotential surfaces, calculating the field from the potential, an isolated conductor

The Mechanical Properties of Materials

- Types of materials, a conductor in electric fields (static condition/dynamic conditions)
- Ohmic materials, Ohm's law (a microscopic view)
- an insulator in an electric field

Capacitance

- Capacitors
- Capacitance

- calculation the capacitance
- capacitors in series and parallel
- energy storage in an electric field
- capacitors with dielectrics
- an atomic view of dielectrics
- dielectrics and Gauss's law magnetic field due to a moving charge
- the magnetic field of a current, two parallel currents
- the magnetic field of a solenoid
- Ampere's law, electromagnetism, and frame of reference

DC Circuits

- Electric current
- electromotive force
- analysis of circuits
- electric fields in circuits
- resistors in series and parallel
- energy transfers in an electric circuit
- RC circuits

The Magnetic field

- Magnetic interactions and magnetic poles
- the magnetic force on a moving charge
- circulating charges, the Hall effect
- the magnetic force on a current-carrying wire
- the torque on a current loop

The Magnetic field of a Current

- The magnetic field due to a moving charge
- the magnetic field of a current
- two parallel currents
- the magnetic field of a solenoid
- Ampere's law, electromagnetism, and frame of reference

Faraday's Law of Induction

- Faraday's experiments
- Faraday's law of induction, Lenz' law
- motional EMF
- generators and motors induced electric fields
- induction and relative motion

Magnetic Properties of Materials

- The magnetic dipole
- the force on a dipole in a non-uniform field
- atomic and nuclear magnetism
- Magnetization
- magnetic materials
- the magnetism of the planets
- Gauss' law for magnetism

Inductance

- Inductance
- calculating the inductance
- LR circuits
- energy storage in a magnetic field
- electromagnetic oscillations (qualitative and quantitative)
- damped and forced oscillations

Alternating Current Circuits

- Alternating currents
- three separate elements
- the single loop RLC circuit
- power in AC circuit, the transformer

Maxwell's Equations and Electromagnetic Waves

- The basic equations of electromagnetism

- induced magnetic fields and the displacement current
- Maxwell's equations
- generating electromagnetic wave
- travelling waves and Maxwell's equations
- energy transport and the Poynting vector
- radiation pressure

Oscillation

- Oscillating systems
- the simple harmonic oscillator
- simple harmonic motion
- energy consideration in simple harmonic motion
- applications of simple harmonic motion
- simple harmonic motion and uniform circular motion
- combinations of simple harmonic motions
- damped harmonic motion
- forced oscillations and resonance

Wave Motion

- Mechanical waves, types of waves
- traveling waves
- Waves Speed
- Waves equation

Power and intensity in the wave motion

- Principle of superposition
- Interference of waves
- standing waves
- resonance

Sound Waves

- The speed of sound
- traveling longitudinal waves

- power and intensity of sound waves
- standing longitudinal waves
- vibrating systems and sources of sound
- Beats, the Doppler effect

Light Waves

- The electromagnetic spectrum
- visible light, the speed of light
- reflection and refraction of light waves
- total internal reflection
- the Doppler effect for light

Mirrors and Lenses

- Image formation by mirrors and lenses
- plane mirrors, spherical mirrors
- spherical reflecting surfaces
- thin lenses
- optical instruments

Interference

- Two-source interference
- double-slit interference
- Coherence
- The intensity in the double-slit interference
- interference from thin films
- optical reversibility and phase changes on diffraction
- Michelson's interferometer, Michelson's interferometer, and light propagation

Diffraction

- Diffraction and the wave theory of light
- single slit diffraction
- The intensity in single slit diffraction
- diffraction at a circular aperture
- double slit and diffraction combined

Gratings and Spectra

- Multiple slits
- A diffraction grating
- dispersion and resolving power
- X-ray diffraction, Holography

Polarization

- Polarization of electromagnetic waves
- polarizing sheets, polarization by reflection
- double refraction, circular polarization
- scattering of light
- to the quantum limit

Temperature

- Temperature and thermal equilibrium
- temperature scales
- measuring temperatures
- thermal expansion
- the ideal gas

Molecular Properties of Gases

- The atomic nature of matter
- a molecular view of a pressure
- the mean free path
- the distribution of molecular speeds
- the distribution of molecular energies
- equations of states for real gases
- the intermolecular forces

The first law of thermodynamics

- Heat (energy in transit)
- the transfer of heat
- the first law of thermodynamics
- heat capacity and specific heat
- work done on or by an ideal gas
- the internal energy of an ideal gas
- heat capacity of an ideal gas
- applications of the first law of thermodynamics

Entropy and the second law of thermodynamics

- Defining entropy
- entropy change for irreversible processes
- the second law of thermodynamics
- entropy and engines
- efficiencies of engines
- A statistical view of entropy

The Nature of Light

- Introducing the photon, thermal radiations
- the photoelectric effect
- Einstein's photon theory
- the Compton effect, the photon revealed
- photons and waves
- slowing down atoms by photon bombardment

The Nature of Matter

- Matter waves
- testing DeBroglie's hypothesis
- waves and particles
- Heisenberg's uncertainty principle
- the wave function, Schrodinger's equation
- barrier tunneling

Electrons in Potential Wells

- Electrons
- free and bound
- an electron trapped in a potential well
- an electron trapped in a finite well
- an electron trapped in an atom
- the ground state of Hydrogen
- the angular momentum of the electron in atoms
- Excited states of the Hydrogen atom
- counting the states of Hydrogen

Atomic Structure

- The X-Ray Spectrum of atoms
- X-Ray and the numbering of the elements
- building atoms, the periodic table
- atomic magnetism, the Stern-Gerlach experiment
- Nuclear magnetic resonance
- magnetism and atomic radiations
- Lasers and Laser light

Nuclear Physics

- Discovering the nucleolus
- some nuclear properties
- radioactive decay, alpha decay
- beta decay
- Measuring ionizing radiation
- natural radioactivity
- nuclear reactions
- nuclear models

Energy from the nucleus

- The atom and the nucleus
- nuclear fission
- theory of nuclear fission
- basic principles of nuclear reactors
- a natural reactor

- The basic process of thermonuclear fusion
- Thermonuclear fusion in stars
- Controller thermonuclear fusion
- magnetic confinement
- inertial confinement

Particle Physics and Cosmology

- Particle interactions
- families of particles
- conservation laws
- the quark model
- the big bang cosmology
- Nucleosynthesis
- the age of the universe

Semiconductors

- Review of conductors
- insulators and semiconductors and band theory of solids
- N- and P-type semiconductors, the diode
- biasing the diode
- voltage-current characteristics of a diode
- Half-wave & full-wave rectifier
- bridge rectifier. Smoothing circuit

Transistor

- The basic structure, biasing
- Operation
- A brief review of transistor configuration
- characteristics of the common emitter
- DC load lines and Q points
- construction and operation of amplifier in common emitter mode.

Feedback, Oscillators and Logic gates

- Principle of feedback amplifiers
- Positive and Negative Feedback
- RC feedback oscillator (phase shift, common emitter mode only) OR, AND, NOT, NAND, NOR gates
- Symbol
- truth table and Boolean equations
- Use of diode and transistor for OR, AND, NOT, NAND, NOR gates

Mechanics

- Modulus of Rigidity by Static methods (Barton's Apparatus), by Maxwell needle or by solid cylindrical rod
- To find surface tension of water by capillary tube method/Jaeger's method
- To study the damping features of an oscillating system
- Measurement of viscosity of liquid by Stoke's / Poiseulli's method
- To determine the value of "g" by compound pendulum / Kater's Pendulum
- To study the dependence of Centripetal force on the mass, radius, and angular velocity of a body in a circular motion
- Investigation of phase change with position in travelling wave and measurement of the velocity of sound by C.R.O
- Determination of moment of inertia of a solid/hollow cylinder and a sphere etc., Spring constant by static and dynamic methods

Electricity and Magnetism

- Calibration of an Ammeter and a Voltmeter by potentiometer
- Conversion of a pointer Galvanometer into a voltmeter and an ammeter
- Charge sensitivity of a ballistic Galvanometer and comparison of capacities by a ballistic galvanometer.
- To study the B.H. curve and measure the magnetic parameters.
- Measurement of low resistance coil by a Carey Foster Bridge.
- Study of the parameter of wave i.e. amplitude, phase and time period of a complex signal by CRO.
- Measurement of self/mutual inductance.
- To study the network theorems (Superposition, Thevenin, Norton)
- To study the application of Lorentz force by CRO (e/m by J. J. Thomson method)
- Determination of temperature coefficient of resistance of a given wire
- Determination of Stefan's constant

- Calibration of the thermocouple by potentiometer

Waves and Optics

To determine Horizontal/Vertical distance by Sextant

The determination of the wavelength of Sodium –D lines by Newton’s Ring

The determination of the wavelength of light/laser by the Diffraction grating

Determination of wavelength of sodium light by Fresnel’s bi-prism

The determination of resolving power of a diffraction grating

The measurement of specific rotation of sugar by Polarimeter and determination of sugar concentration in a given solution

To study the combinations of harmonic motion (Lissajous figures)

To study the parameters of waves

Thermodynamics

To determine thermal emf and plot temperature diagram

To determine the Thermal conductivity of good and bad conductors using Lee’s and Searl’s apparatus

Determination of “J” by Callender – Barnes method

Electronics

- Characteristics of a semiconductor diode (Compare Si with Ge diode)
- Setting up of half and full-wave rectifier and study of following factors i. Smoothing effect of a capacitor ii. Ripple factor and its variation with the load. iii. Study of regulation of output voltage with load.
- To set up a single-stage amplifier and measure its voltage gain and bandwidth.
- To set up transistor oscillator circuit and measure its frequency by an oscilloscope
- To set up an electronic switching circuit using transistor LDR and demonstrate its use as a NOT gate.
- Characteristics of a transistor.

Modern Physics

- To study the characteristics of Photoemission and determination of Plank’s constant using a Photocell

- Determination of e/m of an electron.
- Determination of ionization potential of mercury
- To study the characteristic curves of a G. M. counter
- To determine the absorption coefficient of β -particle in Aluminum by G.M. counter
- Determination of range of α -particles
- The mass absorption coefficient of lead for γ -rays using G.M counter