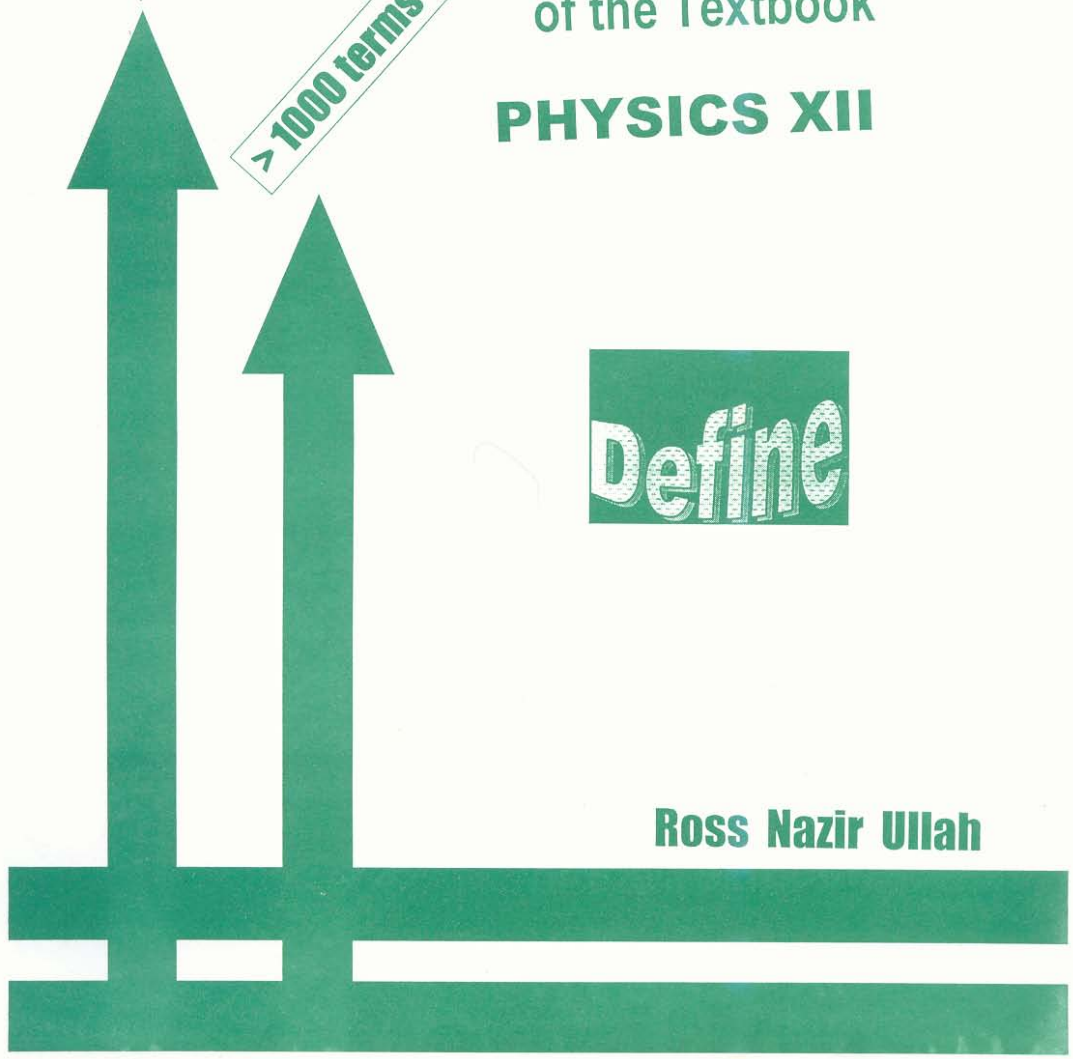
Self Study Series

Definitions

of the Textbook

PHYSICS XII

> 1000 terms



Define

Ross Nazir Ullah

PREFACE

The major definitions of this book have been taken from my book entitled "Basic Physics". This volume is more or less like a dictionary. As you read the text and whenever you stuck with some difficult word, just consult this Book of Definitions. The definitions of some words or terminology are given step by step as the prescribed textbook states. I must confess that few definitions have duplication even on the same page due to step-by-step effort of writing them. An index is added for further convenience at the end.

It took my lots of effort to get the definitions of all the terms mentioned in the text. Starting from my 'Basic Physics', I went to other dictionaries—language, Chemistry and medical dictionaries. In addition to that I consulted computer-based information including the Internet. Sometimes for getting the explanation of even one term was like finding a pearl from the sea!

The readers should point out more words/ terminology not understood in the text. These will be accepted with gratitude so that those can be added in the next edition.
Comments, suggestions and criticisms are invited for the sake of education to improve this book.

Ross Nazir Ullah

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Electrostatics (Chap 12)

Electrostatics: Electricity at rest; electric charges located on insulators.
Electric charge: Quantity of electricity; flow of electrons in a conductor.
Electric current: The rate of flow or charge past a given point in an electric circuit.
Electron: Smallest unit of electric charge.
Proton: An elementary particle with appositive charge (+1.502 C) and rest mass 1.673×10^{-27} kg.
Conductor: A material through which an electric charge is readily transferred.
Conductance: Ability to conduct electricity.
Insulator: A material through which an electric charge is not readily transferred.
Electrification: The process of charging a body by adding or removing electrons.
Coulomb: The quantity of electricity transported in one second by a current of one ampere; equal to charge on 6.25×10^{18} electrons.
Coulomb's law: The force of attraction or repulsion between two point charges is directly proportional to the product of their magnitudes and inversely proportional to the square of distance between them.
Point charges: The charged bodies that are very small as compared with the distance between them.
Permittivity (ε): The ratio of the electric displacement in a dielectric medium to the applied electric field strength, i.e. $\varepsilon = \mathbf{D} / \mathbf{E}$. It indicates the degree to which the medium can resist flow of electric charge. It is measured in farads / meter.
Permittivity of free space (or Electric constant) ε_o : It is equal to $1 / (c^2 \mu_o)$ where c is the speed of light and μ_o is the permeability of free space.
Relative permittivity (or Dielectric constant) ε_r : i) The ratio of the capacitance with a particular material separating the plates of a capacitor to the capacitance with a vacuum between the plates.
ii) It is the ratio of the permittivity of a medium to the permittivity of free space, i.e. $\varepsilon / \varepsilon_o$
Coulomb force: A force of attraction or repulsion resulting from the interaction of the electric fields surrounding two charges particles.
Dielectric (or Dielectric medium): The insulating material between the plates of a capacitor.
Bakelite: A trade name for certain phenol-formaldehyde resins.
Benzene ($C_6 H_6$)**:** A colourless liquid hydrocarbon. It is now made from gasoline from petroleum. (formerly obtained from coal tar)
Mica: A mineral consisting of complex silicates, characterized by a perfect separating along a line of natural splitting enabling the crystals to be split into very thin plates.
Paraffined paper: Waxy paper oiled with petroleum product.
Plexiglas (Perspex or LUCITE): A tough transparent thermoplastic that is much lighter than glass and does not broken off from a whole.
Teflon: Trade name for a form of polytetrafluoroethene.
Polytetrafluoroethene (PTEE): A material with 'anti-stick' properties used for coating cooking utensils and non-lubricated bearings. It's a thermosetting plastic with a high softening point (327 ^oC) prepared under pressure of 45-50 atmospheres.
Electric field: The region in which an electric force acts on a charge brought into the region.
Electric field intensity(or Electric intensity): The force experience by a unit positive charge placed at that point in an electric field.

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Newton's universal gravitational law (or Law of Universal Gravitation): i) The force of attraction between two objects is directly proportional to the product of their masses and inversely proportional to square of distance between their centers.
ii) Everybody in the Universe attracts every other body with a force which is directly proportional to the product of their masses and inversely proportional to the square of the distance between them.

Test charge: A charge placed in the electric field to measure its intensity.

Unit vector: A vector of unit magnitude and points along the required direction.

Density: Amount of charge per unit dimension.

Surface charge density: Amount of charge per unit area.

Volume charge density: Amount of charge per unit volume.

Electric field line (or Electric line of force): i) A line so drawn that a tangent to it at any point indicates the orientation of the electric field at that point.
ii) The path a free positive charge takes when it is placed in an electric field.

Dimension: A measurement of any sort; especially length, height and width.

One dimension: A measurement which needs a single reference point; e.g. a point on line.

Two dimensions: Measurement needing two references; e.g. a point on a plane (x-y plane).

Three dimensions: Measurement which needs three references; e.g. a point in space (x-y-z coordinate system).

Four dimensions: Measurement which needs four references; e.g. a point in space + time coordinates (relativistic frame of reference).

Radial: Lines or parts extending or proceeding from a centre; acting or moving along lines proceeding from a center; Lines going outwards from a central region.

Zero field spot (or Neutral zone): The middle region between like charges where the electric field intensity is zero.

Tangent: A line, curve, or surface which touches another at a single point.

Static charge: Stationary or motionless charge. An accumulation of static electricity on a body.

Xerography: A photographic process, in which the image is formed by electrical effects rather than chemical effects.

Toner: i) In a document copying machine, image forming material used in electrostatic processes.
ii) A thermoplastic material impregnated with lampblack. Toner adheres to the exposed areas on the photoconductor during the developing process and is then transferred to the paper to form the developed image on the paper.

Drum: A hollow cylinder around which the photoconductor is wrapped; the drum continuously rotates during printing and carries the photoconductor past the various stations in the printing process. The drum also contains the photoconductor supply and takeup spools.

Selenium (Se)**:** A metalloid element belonging to group VI of the periodic table. It is a semiconductor. There are a number of allotropic forms, including grey, red, and black selenium. The grey allotropic is light-sensitive and is used in photocells, xerography, and similar applications.

Allotropy: The existence of elements in two or more different forms.

Photoconductor: A medium for transferring images to paper.

Silhouette: An object seen as a dark outline against a lighter background; a dark shadow.

Printer: An output unit that produces a hard copy record of data mainly in the form of a sequence of discrete graphic characters that belong to one or more predetermined character sets.

Inkjet printer: A nonimpact printer in which the characters are formed by projecting particles or droplets of ink onto paper.

Gutter: i) A shallow trough fixed in the base, or a channel at the side, to carry off not worth matter
ii) In multicolumn formatting, the space between columns.

Electrode: i) A conducting element in cell, electronic tube, or semi-conductor device.
ii) Metal or carbon plates in an electric cell.

Droplet: To fall in a small spherical mass of free liquid.

Electric flux: Electric lines of force in an electric field considered collectively.

Intensity: The electric lines of force transmitted per second through a unit area.

Closed surface: A surface without any end, such as, outer surface of a sphere.

Gauss's law: The flux through any closed surface is $1/\in_o$ times the charge enclosed by that surface.

Gaussian surface: A closed surface drawn in an electric field.

Equipotential surface: A surface over which the potential has the same value for all points lying on it.

Surface charge density: Amount of charge per unit area.

Volume charge density: Amount of charge per unit volume.

Electric potential: The quantity which determines the flow of electricity.

Electrostatic equilibrium: Such electric field in which a charged particle move with uniform velocity.

Potential: The quantity which determines the flow of electricity.

Electrical potential energy: The energy involved in bringing it to its current state from some reference state.

Electric potential difference: The work done per unit charge as a charge is moved between two plates in an electric field.

Absolute potential: The amount of work done in moving a unit positive charge from infinity to that point against the electrical forces.

Electroencephalograph (EEG): A sensitive instrument that records the voltage waveforms associated with the brain. The trace obtained is known as an electroencephalogram.

Electroencephalogram: The traces of the voltage waveforms associated with the brain taken from electroencephalograph machine.

Electroencephalography: Study of brain waveforms observed by electroencephalograph.

Potential gradient: The change in potential per unit distance.

Radial: Lines or parts extending or proceeding from a centre; acting or moving along lines proceeding from a center; Lines going outwards from a central region.

Infinitesimal: An extremely small or insignificant quantity, amount, etc.

Shark: A member of a large superorder fishes typically having a long streamlined body, many pointed teeth, five to seven slits as the organs of respiration, rough skin consisting of scales.

Ampullae of Lorenzini: Special organs of sharks those are very sensitive to electric field.

Retina: The inner, sensitive coating of the eye containing the ends of the nerves of sight; the part of the eye which receives images of the object.

Iris: The circular coloured membrane of the eye.

Pupil: The opening in the iris of the eye, through which rays of light pass to the retina.

Cornea: The transparent circular outer covering at the front of the eye, over iris and pupil.

Electroretinography (ERG): Electrotretinography is an eye test used to detect abnormal function of the retina. During the test, an electrode is placed on the cornea to measure the electrical responses to light of the cells that sense light in the retina at the back of the eye. These cells are called the rods and cones.

Electron volt: The energy required to move an electron between two points, which have a potential difference of one volt.

Microscope: An optical instrument for producing an enlarged image of small objects.

Gravitational force (or Force of gravitational attraction): The mutual force of attraction which acts universally between two bodies of matter.

Conservative force: A force is conservative if the work done by that force when moving an object from one point to another is independent of the path taken between those two points; e.g. gravitational force.

Electrostatic (or Electromagnetic or Coulomb) force: Force of attraction or repulsion between two un-like or like charged bodies.

Gravitational constant (G): The constant of proportionality in the equation that expresses Newton's law of universal gravitation: $F = G\, m_1\, m_2 / r^2$. The value of G is 6.67×10^{-11} N m^2 kg^{-2} .

Electric constant (or Permittivity of free space) ε_o : It is equal to $1 / (c^2 \mu_o)$ where c is the speed of light and μ_o is the permeability of free space.

Schematic (schematically, adv**):** Of or relating to a scheme; diagrammatic presentation; such as a figure; e.g. (say) figure 2.

Atomizer: An instrument for changing a liquid to a very fine spray.

Terminal speed: Maximum constant speed of an object falling vertically downward.

Stokes' law: In fluid resistance; The drag force F of a sphere of radius *r* moving with a velocity *v* through a fluid of infinite extent is

$$F = 6 \pi \eta r v$$ where η is the viscosity.

Viscosity: The property of fluids by which they resist their flow due to internal friction.

Coefficient of viscosity: It is equal to the tangential force per unit area required to maintain a unit relative velocity between its two layers, unit distance apart.

Density: Amount of charge per unit dimension.

Capacitor(or Electric condenser): A combination of conducting plates separated by an insulator and used to store an electric charge.

Capacitance: i) The ratio of the charge on either plate of a capacitor to potential difference between the plates.
ii) Capacity of electric condenser, or capacitor, to store electric charges.

Farad: The Farad is the capacitance of a capacitor between the plates of which there appears a difference of potential of one volt when it is charged by a quantity of electricity equal to one coulomb.

Dielectric: The insulating material between the plates of a capacitor (or condenser).

Relative permittivity (Dielectric constant or Dielectric coefficient) : The ratio of the capacitance with a particular material separating the plates of a capacitor to the capacitance with a vacuum between the plates.

Voltmeter: A meter used for measuring potential differences.

Electric polarization: The separation of the charges in the molecules of an insulator as an effect of an electric field. One face of an insulator in a field gains a net positive charge with the other becoming negative.

Dipole: A system of two equal and opposite charges placed at a very short distance apart.

Dipole aerial: TV receiving antenna, cut to one-half wavelength of the transmitted signal.

Resistance: The opposition to the flow of electricity.

Resistor: A component included in the electric circuit because of its resistance.

Time constant: i) Time required by capacitor to deposit 0.63 times equilibrium charge q_o .
ii) Physical quantities such as voltage, current and temperature sometimes decrease with time in such a manner that, at any instant, the rate of decrease of the quantity is given by:

$$-(dv / dt) = v / T$$

where v is the instantaneous value of the quantity, T is time constant.

Current Electricity (Chap 13)

Electricity: The nature and effects of moving or stationary electric charges.
Electric current: The rate of flow or charge past a given point in an electric circuit.
Static electricity (or Electrostatics): Electricity at rest; electric charges located on insulators.
Current electricity (or Electrodynamics): The study of the relationship between mechanical forces and magnetic and electric forces.
Shaft: Anything shaped like an arrow, as the stalk of a plant or broken handle of a cricket bat.
Carbon arc: Current flowing between two carbon electrodes,
Brush: Part of electric generator or motor which serves to transfer current to or from armature.
Conductor: A material through which an electric charge is readily transferred.
Conductance: Ability to conduct electricity.
Ampere: i) The current due to flow of charge at the rate of one coulomb per second.
ii) The current which when flowing through two parallel wires, separated by a distance of one meter from each other gives rise to a force per unit length on each wire equal to $2x10^{-7}$ N/m.
Ampere-turns: Number of turns of a coil carrying current times the number of amperes flowing.
Electron: Smallest unit of negative electric charge.
Electrolyte: A substance whose solution conducts an electric current.
Electronic current: The current due to flow of electrons.
Conventional current: The current due to flow of an equivalent positive charge.
Eel: Any of various snakelike fishes of the genus, members of which spend most of their lives in fresh water but breed in warm deep oceans.
Valence electrons: Electrons in the outermost shell of an atom that are involved in chemical changes.
Drift: To move along under the force.
Drift velocity: The velocity gained by free electrons in an electrical conductor upon the application of electric field; it is of the order of 10^{-3} m/s.
Thermal motion: The motion due to heat energy.
Chemical energy: The kinetic and potential energies of electrons in a chemical compound.
Mechanical energy: Energy transmitted by a machine; energy in the form of mechanical power; the kinetic plus potential energy, if there is no frictional loss.
Heat energy: i) A form of energy associated with molecular motion.
ii) The energy that flows between a system and its environment by virtue of a temperature difference between them.
Solar energy: The energy produced by nuclear fusion in the sun and comprises almost entirely electromagnetic radiation.
Electrical energy: Energy resulting from the position of an electric charge in an electric field.
Hydal energy: Electricity produced from water power by the arrangement of machinery.
Tidal energy: Electricity obtained from the power plant that uses the 'head' of water created by the rise and fall of the ocean tides to spin the water turbines.
Nuclear energy: The energy liberated by a nuclear reaction (fission or fusion) or by radioactive decay.
Electric arc: A luminous electrical discharge with a high current density, occurring between two electrodes.

Electric Cell (or Cell): i) A device which converts chemical energy into electrical energy.
ii) Combination of two metals or a metal and carbon with an electrolyte to generate an electric current.

Battery: A group of electric cells.

Leyden jar: A glass jar coated on its inner and outer surfaces with a conducting material. An early type of capacitor.

Electrolyte: A substance whose solution conducts an electric current.

Electric generator: An electromechanical device that converts mechanical energy into electrical energy.

Thermo-couples: i) Two dissimilar metallic conductors joined at their ends.
ii) Junction of two dissimilar metals, in which an emf is generated by reason of a temperature difference.

Solar cell: A device which converts solar energy or artificial light into electrical energy.

Standard cell: A voltaic cell whose e.m.f. is used as a standard.

Circular coil: A long coil of insulated wire wound on a circular support.

Solenoid: A long helically wound coil of insulated wire.

Toroid: A solenoid wound on a circular support instead of a straight one.

Sulphuric acid ($H_2 SO_4$)**:** A highly corrosive dense oily acid, that is a strong oxidizing agent and is much used in the chemical industry.

Electrolysis: The conduction of electricity through a solution of an electrolyte or through a fused ionic compound, together with the re

Electrolyte: A substance whose solution conducts an electric current.

Electrode: Conducting element in an electric cell, electronic tube, or semi-conductor device.

Anode: The positive electrode or plate of an electronic tube.

Cathode: The negative electrode of an electronic system.

Voltameter: Former name of coulombmeter.

Coulombmeter: An instrument in which the electrolytic action of a current is used for measurement of the quantity of electricity passing through a circuit.

Electroplating: Depositing metal by means of an electric current.

Electrochemical equivalent: The mass of an element in grams, deposited by one coulomb of electricity.

Faraday: The quantity of electricity (96,500 coulombs) required to deposit one chemical equivalent of an element.

Chemical equivalent: The quantity of an element expressed in grams, equal to the ratio of its atomic weight to its valence.

Ohm's law: i) The potential difference is proportional to the current, provided there is no change in the state of the conductor.
ii) The ratio of the emf applied to a closed circuit to the current through the circuit is a constant.
iii) An electric current varies directly as the electromotive force and inversely as the resistance.

Resistance: The opposition to the flow of the electricity.

Resistivity (or Specific resistance): The resistance of a sample of material having specified dimensions.

Ohm: The unit of electric resistance in MKS system; one volt per ampere.

Ohmic: Describing a substance or circuit component that obeys Ohm's law.

Ohm's law: The current (I) in a conductor is proportional to the potential difference (V) between its ends. This leads to, V = IR, where R is the conductor's resistance.

Potential difference: The work done per unit charge as a charge is moved between two points in an electric field.

Semiconductor (or Semiconductor device): A material such as silicon or germanium, that has resistivity midway between that of conductors and that of insulators.

Semiconductor diode: A semiconductor device, either based on semiconductor junction or on point contact, with two electrodes.

Series arrangement: The arrangement in which the components are arranged to provide a single conducting path for current.

Parallel arrangement: The arrangement, in which two or more components are connected across two common points in the circuit so as to provide separate conducting paths for the current.

Series resistances: Resistors are said to be in series if these are connected such that there is only one conducting path through them.

Parallel resistances: Resistors are said to be in parallel when each one of them is connected across the same two points.

Resistivity: The resistance of a sample of material having specified dimensions.

Specific resistance: The resistance of a sample of material having specified dimensions.

Conductance: Ability to conduct electricity.

Mho: The unit of electrical conductance; the reciprocal of the ohmic resistance.

Siemens (S): The SI unit of electrical conductance, defined as the conductance of an element that possesses a resistance of one ohm. The unit used to be called **mho** or reciprocal of ohm.

Lattice: A regular periodic repeated three-dimensional array of points that specify the positions of atoms, molecules or ions in a crystal.

Temperature coefficient (α): The change in resistance per degree change in temperature per ohm at a particular temperature.

Resistance: The opposition to the flow of the electricity.

Thermometer resistance: A thermometer that measures temperature by the change in electrical resistance of a conductor.

Nichrome: A heat resistant alloy with high resistivity that is used in electrical heating elements and resistors. The composition varies but is approximately 62% Ni, 15% Cr and 23% Fe.

Eureka: An alloy of copper and nickel used for electrical filament and resistance wire.

Ceramics: Inorganic materials, such as pottery, enamels, and refractories.

Tolerance: The allowable range of deviation from the nominal value of an attribute.

Manganin: An alloy of 15-25% Mn, 70-86% Cu, and 2-5% Ni, that has a high electrical resistivity and low temperature coefficient of resistance. It is used for electrical resistances.

Rheostat: A variable resistor for regulating electric current.

Potential divider (or Voltage divider): A number of resistors, inductors, or capacitors connected in series with several terminals at intermediate points.

Potentiometer: An instrument for measuring electrical potential differences by balancing two opposing potentials so that no current flows through a galvanometer. .

Thermistor: A semiconductor device that has a large negative temperature coefficient of resistance, and can be used for temperature measurement, or as a controlling element in electronic control circuits.

Circuit breaker: Device other than a fuse which automatically opens an overload electric circuit.

Ampere: i) The current due to flow of charge at the rate of one coulomb per second.
ii) The current which when flowing through two parallel wires, separated by a distance of one meter from each other gives rise to a force per unit length on each wire equal to $2x10^{-7}$ N/m.

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Electrical power: Rate at which energy is expended or work is done. It is measured in watts.
Potential difference: The work done per unit charge as a charge is moved between two points in an electric field.
Emf (or Electromotive force): i) A measure of the energy supplied by a source of electric current.
ii) The energy per unit charge supplied by a source of electricit
iii) The potential difference between the terminals of a battery or cell when it is not supplying current to an external circuit.
Terminal potential difference: The potential difference between the terminals of a battery or cell when it is not supplying current to an external circuit.
Electrical circuit: A combination of electrical components that form a conducting path.
Circuit element: A resistor, capacitor, inductor, transistor, or other device used in making up electric circuits.
Active elements: Those which are capable of delivering power to some external device; such as, voltage and current sources.
Passive elements: Which are capable only, of receiving power; They do not have any source within them.
Electrical network (or Network): A combination of electrical components that form a closed conducting path.
Complex network: Series and parallel combinations of different circuit elements along with many voltage sources.
Branch: In a certain network, each resistor is said to constitute a branch.
Node: A junction of two or more branches is said to be a node.
Reference node (or Datum node): In a network, the junction of the maximum number of branches.
Loop (or Mesh): A closed electrical circuit.
Kirchhoff's First Rule: The sum of all the currents flowing toward a node is equal to the sum of all the currents flowing away from the node.
Kirchhoff's Second Rule: The algebraic sum of voltage changes around a closed circuit or a loop must be equal to zero.
Wheatstone Bridge: A circuit, consisting of four resistances connected in such a way so as to form a mesh, used for accurate measurement of electrical resistance.
Wheatstone: Sir Charles *Wheatstone* (1802-75), English physicist; to designate things invented by or associated with Wheatstone
Post office box: A box containing resistances that can be switched into the circuit, suitable for use as a Wheatstone bridge or potentiometer.
Potentiometer: An instrument for measuring electrical potential differences by balancing two opposing potentials so that no current flows through a galvanometer. .
Galvanometer: An instrument used to measure minute electric currents.
Voltmeter: A meter used for measuring potential differences.
Digital voltmeter (DVM): A voltmeter that displays the measured values as numbers composed of digits.
Cathode ray oscilloscope (CRO): A device used to display input signal into waveform.
Potentiometer: The work done per unit charge as a charge is moved between two points in an electric field.
Potential divider: A number of resistors, inductors, or capacitors connected in series with several terminals at intermediate points.
Aurora: Effect of electric glow discharges observed in the upper atmosphere.
Aurora borealis: Northern lights; seen in the north of the Northern Hemisphere, e.g. it can be seen in Canada.

Electromagnetism (Chap 14)

Electromagnetism: The study of electricity and magnetism with inter related phenomena.
Electric current: The rate of flow or charge past a given point in an electric circuit.
Magnetic field: The region or space near a magnet where the effects of magnetism such as the deflection of a compass needle can be detected.
Compass needle (or Magnetic compass) : A device used to show magnetic force field direction.
Right hand rule: If the wire is grasped in the right hand with the thumb pointing in the direction of the current, the fingers of the right hand will circle the wire in the direction of the magnetic field.
Magnetic induction: The production of magnetic order in a material by an external magnetic field.
Tesla: The SI unit of magnetic flux density, equal to a flux density of one weber of magnetic flux per square meter. $1\ T = 1\ Wb\ m^{-2}$.
Extension of right hand rule: i) First determine the field around the conductor carrying the current. The conductor always experiences a force directed from the region where the two fields reinforce each other to the region where they cancel.
ii) Rotate the current carrying conductor so that the direction of flow of current coincides with the direction of magnetic field. The direction of rotation should be that in which the angle of rotation is smaller. Curl the fingers of the right hand along the direction of rotation. The thumb will point in the direction of the force acting on the conductor.
Electric flux: Electric lines of force in an electric field considered collectively.
Magnetic flux: Lines of force in a magnetic field considered collectively.
Angle of dip: The angle between the direction of the magnetic field at any point and the horizontal.
Weber: The SI unit of magnetic flux, equal to the magnetic flux that, linking a circuit of one turn, produces an emf of one volt when reduced to zero at a uniform rate in one second. 1 Wb = 1 V s
Electric flux density (or Electric displacement): The flux per unit area through a small area at right angles to the field, which is taken surrounding at any point in an electric field.
Magnetic flux density: Number of flux lines per unit perpendicular area of a magnetic field.
Reluctance: Magnetic counterpart of electrical resistance; or the hindrance to the establishment of magnetic lines of force.
Ampere circuital law (or Ampere's law): The product of total path elements around a conductor and magnetic flux density in a complete loop equals μ_o times the total current enclosed by the loop. Mathematically;

$$\Sigma\,(B\cdot\Delta l)_r = \mu_o I$$

Permeability: The property of a material by which it changes the flux density in a magnetic field from the value in air.
Absolute permeability (μ): It is the ratio of the magnetic flux density (B) in a substance to the external magnetic field strength (H) , i.e. $\mu = B / H$
Permeability of free space (or Magnetic constant) μ_o : It is a constant and has a value $4\pi \times 10^{-7}\ H\ m^{-1}$ in SI system and is given the symbol μ_o .
Relative permeability, μ_r : Relative permeability of a substance is the ratio of its absolute permeability to the permeability of free space; i.e. $\mu_r = \mu / \mu_o$
Note that relative permeability is a ratio and it has no units.

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Solenoid: A long helically wound coil of insulated wire.
Phantom: A thing that appears to the sight or other sense but has no material substance.
Parameter: Any of several numerical quantities that can be used jointly to characterize a circuit or network..
Lorentz force: An aspect of the motor effect; the force on a charge Q , moving at velocity *v* across a magnetic field B.

$F = BQ \sin \theta$, θ is the angle between *v* & B.

Alpha particle: A helium nucleus emitted from the nucleus of a radioactive atom.
CRO (or Cathode ray oscilloscope): A device used to display input signal into waveform.
Filament (or Heater): A fine thread of metal, which is heated by the passage of an electric current.
Cathode: The negative electrode of an electronic system.
Fluorescent screen: A surface coated with a luminescent material that fluoresces when excited by electrons, X-rays, etc. and hence displays visual information.
Cathode rays: Radiations emanating from a cathode, under certain conditions, constituting beams of high-speed electrons.
Cathode ray tube: Tube, which makes use of cathode rays.
Coolidge tube: Highly evacuated X-ray tube with filament as source of electrons.
Electron gun: Assembly of electrodes that produces an electron beam.
Grid: In an electronic tube, an electrode used to control the flow of electrons from the cathode to the plate.
Grid bias: The grid to cathode voltage.
Anode: The positive electrode or plate of an electronic tube.
Sweep: i) One complete traverse of the luminous spot on the screen of the CRO is called a sweep.
ii) Movement along an arc around a given center point.
Time base generator: A voltage applied to the generator that is predetermined function of time and is used to deflect the electron beam of a CRO tube so that the luminous spot traverses the screen in the desired manner.
Saw tooth voltage: A common type of voltage which makes saw tooth waveform.
Saw tooth waveform: A periodic waveform whose amplitude varies approximately linearly between two values, the time taken in one direction being very much longer than the time taken in the other.
Three dimensional: Measurement with three references, linked with space.
Synchronize: Occur at the same successive instants of time; keep time *with*; (of two sets of movements etc.) go at the same rate, have coincident periods, etc.; proceed exactly together;
Synchronous motor: Motor whose speed is an exact multiple of the frequency of the a.c. current operating it.
Frequency: Number of waves that pass across a certain point in the medium in unit time.
Phase: The state or condition as regards its position and direction of motion of a particle of a wave.
Phase angle: The angle between the voltage and current vectors.
Calibration: Determination of the absolute values of the arbitrary indications of an instrument.
Couple: Two forces of equal magnitude acting in opposite directions, but not along the same line.
Torque: The physical quantity, which produces angular acceleration.
Radial: Lines or parts extending or proceeding from a centre; acting or moving along lines proceeding from a center; Lines going outwards from a central region.

Galvanometer: An instrument used to measure minute electric currents.

Deflecting couple: A couple which tends to rotate the coil when a current is passed through the coil of a galvanometer.

Torsional couple: The twist in the suspension wire under the action of deflecting couple in a galvanometer.

Restoring couple: The tendency to untwist the suspension wire and restore the coil to its original position after the action of torsional couple.

Hooke's law: Within the limits of perfect elasticity stress is directly proportional to strain.

Stress: The distorting force per unit area set up inside the body.

Strain: The change produced in the dimensions of a body under a system of forces.

Lamp and scale arrangement: In sensitive galvanometers the angle of deflection is observed by means of a small mirror attached to the coil along with a lamp and scale arrangement. A beam of light from the lamp is directed towards the mirror. After reflection from the mirror it produces a spot on a translucent scale placed one meter away.

Pivoted type galvanometer (or Moving coil galvanometer): In this type of galvanometer, the coil is pivoted between two jeweled bearings. The restoring torque is provided by two hair springs which also serve as current leads.

Bearing: A part of machine that supports friction.

Current sensitivity: Current per unit scale division of an electric meter.

Voltage sensitivity: Voltage per unit scale division of an electric instrument.

Stable (or Deadbeat) galvanometer: A galvanometer in which the coil comes to rest quickly after the current passed through it or the current is stopped from flowing through it.

Damping: The reduction in amplitude of an oscillation (or vibration) with time by some form of resistance.

Sensitive galvanometer: A galvanometer is said to be sensitive, if it produces a large deflection for a small current.

Ammeter: A meter used to measure electric current.

Shunt: If two electrical devices or circuits are connected in parallel, either one is said to be in shunt with the other.

Shunt resistance: The resistance connected in parallel with the device or circuit to be shunted.

Voltmeter: A meter used for measuring potential differences.

Calibration: Determination of the absolute values of the arbitrary indications of an instrument.

Ohmmeter: A device for rapid measurement of resistance. It consists of a galvanometer, and adjustable resistance, and a cell connected in series.

AVO meter: It is an instrument which can measure current in amperes, potential difference in volts and resistance in ohms.

Moving coil galvanometer: See the pivoted type galvanometer.

Digital: Pertaining to data in the form of digits.

Digital multimeter: It is an electronic instrument in which digital values are displayed automatically with decimal point, polarity and the unit for V, A or Ω.

Digital recording: A means of recording whereby the audio-frequency signals are converted to a digital form.

Digital circuit: Any circuit designed to respond to discrete values of input voltage and produce discrete output voltage levels.

Digital audio tape: Magnetic tape used for digital recording of sound and also for storing computer information.

Electromagnetic Induction (Chap 15)

Induced emf: The emf produced in the conductor is called induced emf, when a moving conductor is kept moving in the magnetic field.

Induced current: Electric current in a conductor caused by emf set by a changing magnetic field surrounding it.

Electromagnetic induction: The process by which an emf is set in a conductor located in a magnetic field, when the magnetic flux is cut by the conductor.

Magnetic flux: Lines of force in a magnetic field considered collectively.

Electromagnet: A coil of wire wrapped around a core of soft iron. When there is a current in the wire, a magnetic field results; the core becomes magnetized. The core loses its magnetism when the current is switched off. Electromagnets are used in telephones, electric bells, etc.

Permanent magnet: A sample of a substance that retains its magnetism when the external magnetic field is removed.

Temporary magnet: The substance whose magnetism disappears as soon as the inducing field is removed.

Motional emf: The producing of a potential difference when a conductor is moved across a magnetic field.

Electric intensity (or Electric field intensity): The force experienced by a unit positive charge placed at that point in an electric field.

Potential gradient: The change in potential per unit distance.

Faraday's law of electromagnetic induction: i) The average emf induced in a conducting coil of n loops is equal to the negative of the rate at which the magnetic flux through the coil is changing with time.

ii) An electromotive force is induced in a conductor when there is a change in the magnetic field around it.

iii) The electromotive force induced is proportional to the rate of change of the field.

Lenz's law: The direction of the induced current is always such as to oppose the cause which produces it.

Drag: To pull by force or draw along slowly and heavily.

Law of conservation of energy: The total energy of a system cannot change unless energy is taken from or given to the outside. The law is equivalent to the first law of thermodynamics.

Perpetuate: **C**ontinue indefinitely or extend without interruption; to make everlasting.

Magnetic flux: Lines of force in a magnetic field considered collectively.

Mutual induction: The mutual action of the magnetic fields of the primary and secondary coil, or circuits, resulting an induced emf in the secondary.

Mutual inductance: It is the property of mutual induction of the two circuits.

Henry (H): The SI unit of inductance, equal to the inductance of a closed circuit that has a magnetic flux of one Weber per ampere of current in the circuit.

Self induction: The production of an emf in a conductor or coil caused by changes in the current in the conductor (or coil) itself.

Self induced emf: If a magnetic flux is produced through a coil due to current in it. Then changes in the magnetic flux producing an induced emf, called self induced emf.

Self inductance: The property of self induction possessed by a coil; it is also called electromagnetic inertia.

Core (or Core material): A length of soft iron forming the centre of an electromagnet or an induction coil.

Para magnetism: The property of a substance by which it is feebly attracted by a strong magnet.

Diamagnetism: The property of a substance whereby it is feebly repelled by a strong magnet.

Ferromagnetism: The property of a substance by which it is strongly attracted by a magnet.

Ferromagnetic material: The material which contains the property of ferromagnetism.

Rheostat: A variable resistor for regulating electric current.

Back emf: An emf that opposes the normal flow of electric charge in a circuit or circuit element.

Inductor (or Reactance coil): A coil or other piece of apparatus, possessing inductance and selected for use because of that property.

Inductance: A property of an electric circuit that results from the magnetic field set up when a current flows.

Capacitor: A combination of conducting plates separated by an insulator and used to store an electric charge.

Ammeter: A meter used to measure electric current.

Current generator: An electromechanical device that converts mechanical energy into electrical energy.

Alternating current generator: A generator in which the coil connected with two slip rings is rotated by some means in a uniform magnetic field produce an induced emf, which causes an alternating current.

Direct current generator: A generator in which the coil connected with two commutators is rotated by some means in a uniform magnetic field produce an emf, which causes one-directional current.

Commutator: i) A device for reversing the direction of the current in an electric circuit or in some part of a circuit.

ii) The part of a direct current generator that connects the coil to the outside circuit, changing the connections round as the coil rotates.

Faraday's law of electromagnetic induction: The electromotive force induced is proportional to the rate of change of the magnetic field around it;

$$E = -N (\Delta \phi / \Delta t)$$

Slip ring (or Collector ring): A ring, usually made of copper, that is connected to and rotates with a winding, so that the winding may be connected to an external circuit by means of a brush or brushes resting on the surface of the ring.

Concentric: Having a common center, as circles.

Carbon brushes: An electrical contact with a moving part, as on a generator.

Alternating current: An electric current, which has one direction during one part of a generating cycle and the opposite direction during the remainder of the cycle.

Direct current: A current in which the movement of electrons is in one direction only.

Turbine: An engine in which a shaft is rotated by fluid impinging upon a system of blades or buckets mounted upon it.

Steam turbine: Steam engine in which steam drives a rotor.

Alternating current generator: A generator in which the coil connected with two slip rings is rotated by some means in a uniform magnetic field produce an induced emf, which causes an alternating current.

Homopolar generator: In 1831 Michael Faraday discovered it. A copper disc was secured to a cylindrical magnet with paper intervening the two. The poles of the magnet were aligned along the axis of the copper disc. Wires of a galvanometer brushed the center and circumference of the copper. Upon rotation of the copper disc and magnet, an emf was created between the terminals of the galvanometer.

Motor: A machine that does work mechanically when it is driven by an electric current.

D.C. motor: A machine that does work mechanically when it is driven by direct current; Reverse of D.C generator.

D.C.generator: A generator in which the coil connected with two commutators is rotated by some means in a uniform magnetic field produce an emf, which causes one-directional current.

Slip rings: Parts used in an A.C. generator. These are concentric with the axis of the loop and rotate with it.

Split rings: These are two halves of a ring that act as a commutator.

Shaft: Anything shaped like an arrow, as the stalk of a plant or broken handle of a cricket bat.

Turbine: An engine in which a shaft is rotated by fluid impinging upon a system of blades or buckets mounted upon it.

Load: The devices in the circuit of the generator that consume electrical energy.

Motor: The machine which converts electrical energy into mechanical energy.

Dynamo: A small electric generator for converting mechanical energy into electrical energy.

Commutator: The part of a direct current generator that connects the coil to the outside circuit, changing the connections round as the coil rotates.

Armature (or Rotor): A coil of wire formed around an iron or steel core, which rotates in the magnetic field of a generator or motor.

Field coil: A coil that, when carrying a current, magnetizes a field magnet of an electrical machine (dynamo or inductor).

Armature coils: Coil of wires formed around an iron or steel core, which rotates in the magnetic field of a generator or motor.

Back emf: An emf that opposes the normal flow of electric charge in a circuit or circuit element.

Transformer: A device for changing an alternating voltage from a low potential to a high potential or vice versa.

Mutual induction: The mutual action of the magnetic fields of the primary and secondary coil, or circuits, resulting an induced emf in the secondary.

Primary: In a transformer or induction coil, the input winding that carries current and normally induces a current in one or more secondary windings.

Secondary: In a transformer or induction coil, the output winding in which the current is due to inductive coupling with another winding called the primary.

Step up transformer: A transformer for increasing an alternating voltage.

Step down transformer: A transformer for reducing alternating voltage.

Eddy currents: i) Closed loops of induced current circulating in plates perpendicular to the magnetic flux.
ii) Currents induced in the structure of an electric machine.

Magnetic hysteresis: The lagging of magnetization of ferromagnetic material behind the magnetizing force.

Hysteresis loop: The loop formed by magnetic hysteresis.

Alternating Current (Chap 16)

Alternating current: An electric current, which has one direction during one part of a generating cycle and the opposite direction during the remainder of the cycle.

Direct current: A current in which the movement of electrons is in one direction only.

Polarity: The distinction between the positive and negative parameters in an electrical circuit or device.

Waveform (or Wave shape): Of a periodic quantity. The shape of the graph obtained by plotting the instantaneous values of the quantity against time.

Sinusoidal: Of a periodic quantity. Having a waveform that is the same as that of a sine function.

Instantaneous value of current: The magnitude of varying current at any instant of time.

Instantaneous value of voltage: The magnitude of varying voltage at any instant of time.

Peak value: The maximum value attained by an alternating current.

Peak to peak value: It is the sum of the positive and negative peak values.

Root mean square (rms) value of current (or Effective value of current): The magnitude of an alternating current which, in a given resistance, produces heat at the same average rate as that magnitude of steady direct current.

Lagging: The time or angle by which one periodic quantity is delayed with respect to another.

Phase: The state or condition as regards its position and direction of motion of a particle of a wave.

Lead: The interval of time or the angle by which a particular phase in one wave is in advance of the similar phase in another wave.

Lag: The time or angle by which one periodic quantity is delayed with respect to another.

Electrical network: The interconnection of circuit elements (in any way) is called a network.

Electrical circuit: A combination of electrical components that form a conducting path.

A.C. circuit: An electric circuit having alternate voltage source.

Circuit element: A resistor, capacitor, inductor, transistor, or other device used in making up electric circuits.

Inductor: A device usually a coil, possessing inductance which acts on another to produce an electromotive force or a current. A conductor or device in which an electromotive force or current is induced or used on account of its inductance.

Inductive reactance: Reactance in an a.c. circuit, due to inductance, which produces a lagging current.

Capacitive reactance: Reactance in an a.c. circuit, due to capacitance, which produces a lagging voltage.

Inductance: The property of an electric circuit by which a varying current induces an emf in that circuit or a neighboring circuit.

Reactance: The non-resistive opposition to current in an a.c. circuit.

Induction coil: Device for generating high voltages.

Induction motor: Motor with rotating magnetic field.

Capacitance: : i) The ratio of the charge on either plate of a capacitor to potential difference between the plates.
ii) Capacity of electric condenser, or capacitor, to store electric charges.

Resistance: The opposition to the flow of electricity.

Choke (or Choke coil): Coil with high inductive reactance.
Impedance: The joint opposition of reactance and resistance to the current in an a.c. circuit.
Impedance matching: A technique used to insure maximum transfer of energy from the output of one circuit to the input of another.
R-C series circuit: A circuit containing a resistance R and a capacitor C in series excited by an alternating voltage.
R-L series circuit: A circuit containing a resistance R and inductance L in series excited by an A.C. source.
Power dissipation: The continuous loss of energy from an electrical device, by its conversion into heat.
Power factor: i) The cosine of the phase angle between current and voltage in an A.C. circuit.
ii) Ratio of true power to apparent power.
R-L-C series circuit: A circuit containing a resistance R, inductance L and a capacitor C in series excited by an alternating voltage source.
Resonance: The condition in an a.c. circuit in which the inductive reactance and capacitive reactance are equal and cancel each other. $X_L = X_C$
Resonance frequency: The frequency observed when inductive reactance and capacitive reactance have same values in a resonant circuit.
Parallel resonance circuit (or Rejecter circuit): A circuit in which inductor and capacitor are in parallel, so that a minimum current flows at the resonant frequency.
Series resonance circuit (or Acceptor circuit): A condition in which the impedance of a series circuit containing resistance, inductance, and capacitance is equal to the resistance of the circuit, and the voltage across the circuit is in phase with the current.
L-C parallel circuit: A circuit containing an inductance coil l and a capacitor C in parallel, excited by an alternating source of voltage whose frequency can be varied.
Lagging current: An alternating current that, with respect to the applied emf producing it, has a lag.
Three phase: Having three equal alternating voltages between which there are relative phase difference of 120^o .
A.C. generator: A generator in which the coil connected with two slip rings is rotated by some means in a uniform magnetic field produce an induced emf, which causes an alternating current.
Oscillating mass-spring system: A system having a spring acting on a body that slides on a frictionless horizontal surface. And energy oscillates between potential and kinetic energies.
Electrical oscillator: i) An L-C circuit in which energy oscillates between a capacitor and an inductor.
ii) Electric device which generates electric waves.
Search coil: A small coil, in which induced currents are used to measure magnetic field strengths.
Oscillator frequency: The frequency of an oscillator in an electrical resonance circuit.
Beat note (or Beats): The condition whereby two sound waves form an outburst of sound followed by an interval of comparative silence.
Choke (or Choke coil): Coil with high inductive reactance.
Propel: To derive onward, push as a bicycle.
Propeller: One who that which derives forward, especially, a device with blades for causing an airplane or a ship to progress.

Maxwell's equations: [Simple Understandable Form] A series of classical equations that govern the behaviour of electromagnetic waves in all practical situations. They connect vector quantities applying to any point in a varying electric or magnetic field. The equations are

$\mathbf{E} \cdot \mathbf{A} = Q / \epsilon_o$ (Gauss' law for electricity)

$\mathbf{B} \cdot \mathbf{A} = 0$ (Gauss' law for magnetism)

$\varepsilon = - N (\Delta\phi / \Delta t)$ (Faraday's law of induction)

$\Sigma (\mathbf{B} \cdot \Delta \mathbf{L})_r = \mu_o I$ (Ampere's law)

Electromagnetic waves (or Electromagnetic radiation): Transverse waves in space having an electric component and a magnetic component, each being perpendicular to each other and both perpendicular to the direction of propagation. These do not require any medium for its motion.

Orthogonal: Pertaining to or involving right angles, at right angles; right-angled; rectangular.

Radio waves (or Radio frequency): The frequency of electromagnetic radiation within the range used in radio, i.e. from $3x10^7$ to $3x10^9$ Hz.

Microwaves: An electromagnetic wave with a wavelength in the range 1 mm to 100 mm, i.e. with a frequency in the range 300 to 3 GHz.

Infrared rays: Electromagnetic waves longer than ordinary light waves but shorter than radio waves; frequencies from 20 to 20,000 cps or Hz.

Visible light (or Light): The aspect of radiant energy of which an observer is visually aware.

Antenna (or Aerial): That part of a radio or TV system from which energy is transmitted into, or received from space or atmosphere.

Transmitting antenna: i) The piece of wire along which charges are made to accelerate.
ii) Wires mounted to transmit outgoing radio or TV signals, usually elevated.

Receiving antenna: i) A wire in which electrons move with oscillating electric field as that of the wave intercepting the wire.
ii) Wires mounted to receive incoming radio or TV signals, usually elevated.

Transmitter: In any communications system, the device, apparatus, or circuits by means of which the signal is transmitted to the receiving parts of the system.

Transmitting station: The station or place which transmits the signals to be received by the receiver.

Radio receiver set (or Radio): The apparatus which use the process of communication across space by the transmission and reception of an electromagnetic wave of radio frequency without the use of connecting wires or other material link.

Modulation: i) Variation of radio frequency waves by means of audio frequency waves.
ii) Variation of the amplitude, frequency or phase of electromagnetic waves, especially for carrier waves.

Amplitude modulation (A.M.): Variation of a carrier wave by changes in the amplitude of the wave.

Frequency modulation (F.M.): Variation of a carrier wave by changes in the frequency of the wave.

Sinusoidal current: The current that has a waveform that is a sine wave.

Sine wave: Waveform resulting from plotting sine of an angle against the angle. Any motion that can be plotted so as to give a sine wave is a simple harmonic motion.

RMS (effective) value: The magnitude of an alternating current which, in a given resistance, produces heat at the same average rate as that magnitude of steady direct current.

Incandescent: Glowing with heat; white-hot.

Physics of Solids (Chap 17)

Material: Of or pertaining to matter or substance; formed or consisting of matter·
Matter: Any material object composed of molecules, which is solid, liquid, or gaseous, and that occupies space and can effect one or more of our senses.
Hardness: The resistance that a face of the crystal offers to scratching, which may differ in different directions. For many substances, hardness is an inverse measure of plasticity.
Ductility: i) The property of a metal which can be drawn through a die to produce a wire.
ii) Ability of a substance to be drawn into fine wires.
Malleability: The property of a metal, which can be hammered or rolled into sheets.
Electrical conductivity: The ability of a material to conduct electric current; the reciprocal of the resistivity.
Thermal conductivity: A measure of the ability of a material to conduct energy.
Bonding of atoms: A strong force of attraction holding atoms together in a molecule or crystal.
Crystalline: Having a regular arrangement of particles.
Crystalline solids: Solids with a definite, fixed melting point.
Molecule: A single atom or a group of atoms joined by chemical bonds. It is the smallest unit of a chemical compound that can have an independent existence.
Solid: The state of matter, which has definite volume and definite shape.
Solidification: The change of state from a liquid to a solid.
Ceramics: Inorganic materials, such as pottery, enamels, and refractories.
Production of X-rays (or Inverse photoelectric effect): The emission of photons of radiations due to the bombardment on a material with high speed electrons.
X-rays: i) Invisible penetrating radiation of great penetrating power.
ii) Electromagnetic radiation of extremely short wavelength.
Adhesion: i) The force of attraction between unlike molecules.
ii) The interaction between the surfaces of two closely adjacent bodies that causes them to cling together.
Cohesion: i) The force of attraction between like molecules.
ii) The tendency of the different parts of a body to maintain their relative positions unchanged.
Cohesive forces: The forces of attraction between the particles, e.g., atoms, molecules, or ions, in crystalline solids.
Melting point: The temperature at which a solid changes to a liquid.
Ice point: The temperature of melting ice, 0^{o} C.
Amorphous solids (or Glassy solids): Solids having a random arrangement of particles; non-crystalline solids.
Polymer: A substance having large molecules consisting of repeated units. Synthetic polymers are extensively used in plastics.
Synthetic: Describing a substance that has been made artificially; i.e. one that does not come from a natural source.
Synthetic materials: Materials that are made artificially.
Synthetic rubber: Artificially made rubber.
PVC (Polyvinyl chloride or Polychloroethene): A tough white solid material, which softens with the application of a plasticizer. It is easy to colour and resistant to fire, chemicals, and weather.
Plasticizer: A substance added to a synthetic resin to make it flexible.

Resin: A synthetic or naturally occurring polymer.

Polythene (Polyethene or Polyethylene): A flexible waxy translucent thermoplastic made in a variety of ways producing a polymer of varying characteristics.

Translucent: Semi-transparent or capable of letting light through so as to allow objects to be indistinctly visible.

Polystyrene: A clear glasslike material used as both a thermal and electrical insulator and for packing and decorative purposes.

Nylon: Any of various synthetic thermoplastic polymers whose molecules are linear polyamides, many of which are tough, lightweight, and resistant to heat and chemicals, and may be produced as filaments (widely used in textiles) or sheets, or as moulded objects.

Hydrocarbon: Chemical compounds that contain only carbon and hydrogen.

Crystal lattice (or Lattice): A regular periodic repeated three-dimensional array of points that specify the positions of atoms, molecules, or ions in a crystal.

Unit cell: Smallest crystal unit possessing the entire symmetry of whole periodic structure.

Squeeze: An application of strong or firm pressure.

Schematic (Schematically adv**):** Of or relating to a scheme; diagrammatic representation; such as a figure, e.g. (say) figure 2.

Inter atomic cohesive force: The force of attraction between like atoms in crystalline solids.

Elasticity: The property of a material body to regain its original condition, on the removal of the deforming forces.

Stress: The distorting force per unit area set up inside the body.

Strain: The change produced in the dimensions

Tensile stress: The stress tending to stretch a body.

Compressive stress (or Bulk stress): It is an overall force per unit area (pressure) applied.

Shear stress: It is a stress tending to produce an angular deformation. It is the tangential force per unit area.

Tensile strain: It is the change in length divided by the original length ($\Delta l / l$). It applies to the stretching of a body; the strain produced as a result of tensile stress.

Compressive strain: The strain produced as a result of compressive stress.

Volumetric strain (or Bulk strain): It is the change in the volume divided by the original volume. It occurs when a body is subjected to a pressure.

Shear strain: It occurs when an angular deformation occurs, and is equal to the angular displacement produced.

Radian: The angle subtended at the center of a circle by an arc equal in length to its radius.

Elasticity: The property of a material body to regain its original condition, on the removal of the deforming forces.

Modulus of elasticity (or Elastic modulus): The ratio of the stress on a body to the strain produced. There are various modulii of elasticity depending on the type of stress applied.

Young's modulus: Linear elasticity, or elasticity of length.

Bulk modulus: Elasticity of volume, corresponding to volume strain.

Shear modulus: The ratio of the shear stress on a body to the shear strain produced.

Elastic constant: Such as Young's modulus, relating stress to strain in a homogeneous medium. For an isotropic material, two constants are required to specify the behaviour and these are related by linear equations. In general, an anisotropic solid is described by 21 elastic constants.

Isotropy: A medium is isotropic if the value of a measured physical quantity does not depend on the direction.

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Anisotropy: A medium is anisotropic if a certain physical quantity differs in value in different directions. Most crystals are anisotropic electrically; polarization properties result from differences in transmission of electromagnetic radiation in different directions.

Tensile test: Measuring the extension of a metal wire at a specified deformation rate and the stresses generated during deformation, from a suitable electronic device fitted in the mechanical testing machine.

Ductility: Combination of properties of a material that enables it to be drawn out into wires.

Ductile material: Materials that have property, that enables it to be drawn out into wires.

Proportional limit: That point up to which a material obeys Hooke's law. The strain produced is proportional to the stress and the sample returns to its original dimensions if the stress is removed.

Elastic limit: The point above the proportional limit where the material no longer obeys Hooke's law.

Hooke's law: Within the limits of perfect elasticity stress is directly proportional to strain.

Elastic deformation: Temporary deformation produced in a material, which can be regained to its original shape or dimensions, on removing the applied stress.

Yield stress: The minimum stress for creep to take place. Below this value any deformation produced by an external force will be purely elastic.

Creep: The slow permanent deformation of a crystal or other specimen under sustained stresses.

Plastics: Materials that, though stable in use at normal temperature, are plastic at some stage in their manufacture, and can be shaped by the application of heat and pressure.

Plasticity: The tendency of a material to suffer a permanent deformation; i.e. not to return to its original dimensions after a deforming stress has been removed. An elastic material becomes plastic above its yield point.

Yield point: The point at which the material begins to 'flow', i.e. the strain increases with time up to breaking point without further increase in the stress.

Ultimate strength: The limiting stress, in terms of force per original unit area of cross section, at which a material completely breaks down, fractures or crushes.

Ultimate tensile strength: The limiting change in length , in terms of force per original length, at which a material completely breaks down.

Fracture stress: The point where the material breaks after crossing the point in ultimate tensile stress.

Ultimate tensile stress: The maximum stress that a material can withstand; regarded as the normal strength of the material.

Ductile substances: Substances that undergo plastic deformation until they break.

Brittle substances: Substances that break just after the elastic limit is reached.

Elastic: A material that tends to resume its original size and shape after being subject to deforming stresses.

Diverse: Differing from itself in different circumstances, at different times, or in different parts; varied; changeful.

Strain energy: It is the potential energy stored in the body because of an elastic deformation, which is equal to the work done to produce this deformation.

Diamond: The hardest known mineral. It is an allotropic form of pure carbon that has crystallized in the cubic system under great pressure.

Carbon ($_6$C)**:** A nonmetallic element belonging to group IV of the periodic table. It has two main allotropic forms, diamond and graphite.

Semiconductor (or Semiconductor device): A material such as silicon or germanium that has a resistivity midway between that of conductors and that of insulators.

Silicon ($_{14}$Si)**:** An element having four electrons in its outermost shell called valence electrons. It is used in semiconductor devices in the form of single crystal.

Germanium ($_{32}$Ge)**:** A brittle metalloid, used as a semiconductor in solid-state electronic devices and as a constituent of alloys, phosphors, and infrared glasses.

Bohr model (or Bohr atomic model): It is based on the following three postulates:

1) An electron in an orbit around the nucleus does not radiate energy.
2) Only those orbits are possible for which the angular momentum of the electron is an integral multiple of $h / 2\pi$.
3) An electron does not emit light when it is moving in one of the allowed orbits. It emits light only when electron jumps from one orbit (outer) to another orbit (inner).

Free electron theory: The atoms have electrons revolving around the nucleus in orbits. In certain atoms, electrons in outer most orbits are loosely bound, called free electrons. A small amount of energy shell let these electrons leave the atom.

Energy band theory: The electrons in a solid have different energy levels. The electrons can exist in some ranges of permissible energy levels and cannot exist in other ranges of forbidden energy levels. The permissible levels taken in groups are called energy bands.

Wave mechanical model: The theory based upon Schrodinger's wave equation.

Schrodinger's wave equation: The equation of wave mechanics that gives mathematical expression to wave motion; $\Delta \psi + \frac{8 \pi^2 m}{h^2} (E + U) = 0$

Energy states: Energy levels around the nucleus of an atom in which electrons can exist.

Energy band: The permissible energy levels taken in groups called energy bands within which the levels are very close and they appear to be continuous.

Discrete: Taking only certain values; Separate, detached from others; individually distinct; not continuous; Consisting of or pertaining to distinct or individual parts of a magnitude or quantity.

Continuous energy band: Closely spaced permissible energy states in which electrons can exist.

Forbidden energy states: A range of energy states which cannot be occupied by electrons, found in between two consecutive permissible energy bands.

Valence electrons: Electrons in the outermost shell of an atom that are involved in chemical changes.

Conduction band: The band above the valence band. In it electrons move freely and conduct electric current through solids.

Valence band: Energy band occupying valence electrons in the outer most shell of an atom.

Insulator: A material through which an electric charge is not readily transferred.

Conductor: A material through which an electric charge is readily transferred.

Semi-conductor: A material such as silicon or germanium that has a resistivity midway between that of conductors and that of insulators.

Intrinsic semi-conductor: A pure semiconductor material. In it the concentrations of negative charge carriers (electrons) and positive charge carriers (holes) are the same.

Extrinsic semi-conductor: Such material in which certain impurities are added. Its conductivity increases considerably depending strongly on the type and concentration of the impurity.

Doping: The process of adding impurity to control the conductivity is called doping.

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Chemical bond: A strong force of attraction holding atoms together in a molecule or crystal.

Ionic bonds: These bonds are formed by transfer of electrons.

Covalent bond: They are formed by sharing of valence electrons rather than by transfer.

Pentavalent element: The elements having a valency of five.

N-type semi-conductor (or N-type germanium): Electron rich semi-conductor (or germanium) consisting of equal number of free electrons and bound positive charges so that the net charge is zero.

P-type semi-conductor (or P-type germanium): "Hole rich" semi-conductor (or germanium) consisting of equal number of free positive holes and bound negative charges so that the net charge is zero.

Phosphorous ($_{15}$P **):** A nonmetallic element belonging to group IV of the periodic table. It is highly reactive. It is an essential element for living organisms.

Hole: In a solid, an empty state near the top of the valence band. Electrons can move into such empty states from adjacent occupied states, permitting the conduction of a current.

Free electron: An electron that is not permanently attached to a specific atom or molecule and is free to move under the influence of an applied electric field.

Electronic current: The current due to flow of electrons.

Conventional current: The current due to flow of an equivalent positive charge.

Superconductivity: The effective disappearance of electrical resistance in certain substances when they are cooled close to absolute zero. Currents induced in circuits of such materials have persisted for several years with no measurable change.

Superconductor: A substance having the properties of super conductivity.

Critical temperature (T_C): The upper limit of temperatures at which it is possible to have a substance in its *liquid* state.

Magnetic resonance imaging (MRI): A technique that is based on nuclear magnetic resonance of protons, and is used in diagnostic medicine to produce images (proton-density maps) of the body.

Nuclear magnetic resonance (NMR): An effect observed when radio-frequency radiation is absorbed by matter. A nucleus with a spin has a nuclear magnetic moment. In the presence of an external magnetic field this magnetic moment precesses about the field direction.

Precession: If a body is spinning on an axis, the axis of rotation can itself move around another axis at an angle to it.

Magnetic levitation train (or Maglev train): A high speed ground transportation vehicle levitated above a track called a guideway and propelled by magnetic fields. A short-distance maglev train has been operating since 1984 in England. Train speeds 517 km/h have been demonstrated in Japan.

Levitate: Cause something heavier to rise or remain suspended without visible means e.g. using magnetic forces.

Propel: Drive or push something forward, cause to move onwards.

Computer chip (or Chip): A small piece of single crystal of semiconductor material containing either a single electronic component or an integrated circuit.

Alloy: A mixture of two or more metals or of a metal with small amounts of non-metals.

Magnetic dipole: A pair of north-seeking and south-seeking magnetic poles a distance apart, as in a bar magnet.

Magnetic pole: Point in a magnet from which lines of force appear to radiate.

Magnetic moment (or Magnetic dipole moment): The torque experience by a magnetic dipole in a field of unit magnetic field strength perpendicular to it.

Para magnetism: Property of a substance by which it is feebly attracted by a strong magnet.

Diamagnetism: Property of a substance whereby it is feebly repelled by a strong magnet.

Ferromagnetism: The property of a substance by which it is strongly attracted by a magnet.

Paramagnetic substances: The substances in which, the orbits and the spin axes of the electrons in the atom are so oriented that their fields support each other and the atoms behaves like a tiny magnet.

Diamagnetic substances: The substances in whose atoms, there is no resultant field as the magnetic fields produced by both orbital and spin motions of the electrons might add up to zero.

Ferromagnetic substances: The substances in which, the atoms cooperate with each other in such a way so as to exhibit a strong magnetic effect.

Domain: A region inside a ferromagnetic material in which all the atomic magnetic fields point the same way.

Squid: (super-conducting *q*uantum *i*nterference *d*evice) Any of a family of super-conducting devices that are capable of measuring extremely small magnetic fields, voltages, and currents.

Soft magnetic material: The material whose domains are easily oriented on applying an external field and readily return to random positions when field is removed.

Hard magnetic material: The material whose domains are not so easily oriented on applying an external field. They require very strong external fields, but once oriented, retain the alignment.

Curie temperature (or Curie point): The temperature above which a ferromagnetic substance loses its ferromagnetism.

Organic material: A material containing carbon combined with hydrogen, and often also with oxygen, and other elements.

Hysteresis (or Magnetic hysteresis) : The lagging of magnetization of ferromagnetic material behind the magnetizing force.

Hysteresis loop: The loop formed by magnetic hysteresis.

Magnetic flux density: Number of flux lines per unit perpendicular area of a magnetic field.

Remanence (or Retentivity): i) The residual magnetic flux density in a substance when the magnetizing field strength is returned to zero.
ii) When substances are applied forces for producing magnetization and then force removed then power of retaining their original magnetization is called retentivity.

Coercivity: Degree of reversed magnetizing force required to deprive the metal of the whole of its original magnetization.

Coercive force: The magnitude of coercicity.

Coercive current: The reversed magnetizing current required to reduce the magnetization in a material to zero.

Hysteresis loss: The dissipation of energy that occurs, due to magnetic hysteresis, when the magnetic material is subjected to cyclic changes of magnetization.

Polymeric solids: Solid substance having large molecules consisting of repeated units. Synthetic polymers are extensively used in plastics.

Intrinsic semi-conductor: A pure semiconductor material. In it concentrations of negative charge carriers (electrons) and positive charge carriers (holes) are the same.

Extrinsic semi-conductor: Such material in which certain impurities are added. Its conductivity increases considerably depending strongly on the type and concentration of the impurity.

Pascal: The SI unit of pressure, equal to a pressure of one Newton per square metre.

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Electronics (Chap 18)

Electronics: i) The study and use of circuitry involving such components as semiconductors, resistors, capacitors, and inductors.
ii) The branch of Physics which is concerned with the emission, behaviour and effects of electrons.

Analogue: Pertaining to data that consists of continuously variable quantities.

Digital: Pertaining to data that consist of digits. Discrete not continuous.

Semiconductor: A material such as silicon or germanium, that has a resistivity midway between that of conductors and that of insulators.

Integrated circuit (IC): A circuit that incorporates numerous components into one unit.

Monolithic IC: A single chip of silicon is the base onto which all the individual components are integrated during manufacture and cannot be dismantled.

Hybrid IC: It consists of one or more monolithic ICs mounted on a base or several components similarly mounted and interconnected. After manufacture it cannot be dismantled.

Chip: A small piece of single crystal of semiconductor material containing either a single electronic component or an integrated circuit..

Black box: A unit whose internal structure is unknown but whose function is documented. It refers to circuits or to program code that performs a certain function. The internal mechanics of the function don't matter to the reader.

Doping: The process of adding impurity to control the conductivity is called doping.

Impurities: In a semiconductor. Foreign atoms, either naturally occurring or deliberately introduced into the semiconductor. They have a fundamental effect on the amount and type of conductivity.

Trivalent impurity: Atoms used as impurity having three valence electrons in the outer most shell.

Pentavalent impurity: Atoms used as impurity having five valence electrons in the outer most shell.

P-n junction: The plane at which a P-type semiconductor crystal meets an N-type semiconductor crystal.

Depletion region (or Layer): A space-charge region in a semiconductor in which there is a net charge due to insufficient mobile charge carriers. They are formed at interface between a p-type and n-type semiconductor in the absence of an applied field.

Space-charge region: In any device, a region in which the net charge density is significantly different from zero.

Surface charge density: Amount of charge per unit area.

Volume charge density: Amount of charge per unit volume.

Potential barrier: The region in a field of force in which the potential is such that a particle, which is subject to the field, encounters opposition to its passage.

Forward biased: The potential applied across the p-n junction so as to decrease the height of the potential barrier, which facilitates the conduction of current.

Reverse biased: The potential applied across the p-n junction so as to increase the height of the potential barrier.

Cut-off bias: The smallest negative grid voltage for a given plate voltage, which causes a vacuum tube to cease to conduct.

Bias: Potential applied to electrode in an electronic device to produce desired characteristics.

Covalent bond: They are formed by sharing of valence electrons rather than by transfer.

Grid: In an electronic tube, an electrode used to control the flow of electrons from the cathode to the plate.

Grid bias: The grid to cathode voltage.

Reverse current (or Leakage current): Flowing of very small current across p-n junction, due to flow of minority charge carriers when reverse biased of the junction.

P-n junction: The plane at which a P-type semiconductor crystal meets an N-type semiconductor crystal.

Semi-conductor diode: A semiconductor device, either based on semiconductor junction or on point contact, with two electrodes.

Rectification: The process of changing alternating current to direct current.

Rectifier: An electrical conductor that allows current to flow through it in one direction only, thus enabling the conversion of a.c. to d.c.

Half-wave rectification: Process in which only alternate half waves of the single- phase a.c. input wave are effective in delivering unidirectional current to the load.

Full-wave rectification: The process in which a circuit rectifies both the positive and negative half-cycles of the single-phase a.c. input and delivers unidirectional current to the load.

Light emitting diode (LED): A semiconductor diode, made from certain materials (e.g. gallium arsenide), in which light is emitted in response to the forward-bias current.

Photo diode: A semiconductor diode that produces a significant photo-current when illuminated.

Photo current: Current produced due to photo electric effect.

Photo voltaic cell: An electronic device that uses the photovoltaic effect to produce an emf. For example a solar cell.

Photovoltaic effect: An effect arising when a junction exists between two dissimilar materials and one of the materials is exposed to electromagnetic radiation, usually in the range near ultraviolet to infrared.

Gallium arsenide (GaAs) devices: Semiconductor devices based on the 3-5 semiconductor gallium arsenide. The semiconductor properties of GaAs give it several advantages over silicon for certain applications. For example, it has a high drift mobility, allowing it to be used for high speed applications such as high speed logic circuits.

Logic circuit: A circuit designed to perform a particular logical function based on the concepts of "and", "either-or", "neither-nor", etc. Normally these circuits operate between two discrete voltage levels, i.e. high and low logic levels, and described as binary logic circuits.

Photovoltaic cell: An electronic device that uses the photovoltaic effect to produce an emf. For example, a solar cell.

Voltaic panels: Series-parallel arrays of photovoltaic cells, thousands in number, in the p-n junction, to obtain greater power from incident light.

Satellite: A smaller body that revolves around a larger body.

Solar energy: The energy produced by nuclear fusion and comprises almost entirely electromagnetic radiation.

Transistor: i) A transistor consists of a single crystal of germanium or silicon which is grown in such a way that it has three regions.

ii) A semiconductor device used as a substitute for vacuum tubes in electronic operations.

Base: The region in a bipolar junction transistor that separates the emitter and collector and to which the base electrode is attached.

Emitter: Region in a bipolar junction transistor from which carriers flow, through emitter junction, into the base. The electrode attached to this region is the emitter electrode.

Collector: The electrode in a transistor through which a primary flow of carriers leaves the inter-electrode region.

Carrier: An electron or hole that can move through a metal or semiconductor. carriers enable charge to be transported through a solid and are responsible for conductivity.

P-n-p transistor: A device taking central region as P-type region both sides of which junctions form with N-type crystals.

N-p-n transistor: A device taking central region as N-type region both sides of which junctions form with P-type crystals.

Current amplification factor: The ratio of the output current to the input current in a transistor.

Current gain (β): In a given transistor, the ratio of collector current I_C to base current I_B ;

$$\beta = I_C / I_B$$

Amplifier: A device consisting of one or more vacuum tubes or transistors to increase the strength of a signal.

Microphone: A device for converting an acoustic signal into an electric signal. It forms the first element of the telephone, the broadcast transmitter, and all forms of electrical sound recorders.

Switch: A device for opening or closing a circuit or for changing its operating conditions between specified levels.

Capsule: A small case, container or vessel for enclosing something.

Operational amplifier (or Op-amp): A very high gain voltage amplifier, with very high input impedance, usually having its output voltage very much greater than the voltage difference between its two inputs.

Input resistance: It is the resistance between the positive and negative inputs of the amplifier. It has very high value.

Out put resistance: It is the resistance between the output terminal and ground in the amplifier. Its value is only a few ohms.

Open loop gain: It is the ratio of output voltage V_o to the voltage difference between non-inverting and inverting inputs when there is no external connection between the output and the inputs of the amplifier.

Inverting amplifier: In op-amps, the input signal that is to be amplified, is applied at inverting terminal through a resistance with certain potential. The non-inverting terminal is grounded having zero potential.

Non-inverting amplifier: In op-amps, the input signal is applied at non-inverting terminal. Due to high open loop gain, the inverting and non-inverting inputs are at the same potential. And input and output signals are in phase.

Comparator: A circuit, such as a differential amplifier, that compares two signals and produces an output that is a function of the result of the comparison.

Differential amplifier: A type of amplifier with two inputs, whose output is a function of the difference between the inputs.

Light dependent resistance (LDR): Such resistance whose value depends upon the intensity of light falling upon it.

Digital system: A system that deals with quantities or variables those have only two discrete values or states.

Manipulation: Working or operating skillfully. Experimental procedure or technique

Operation: A process in which a number, quantity, expression, etc. is altered or manipulated according to set formal rules, as those of addition, multiplication, differentiation, negation, etc.

Mathematics: The science that treats of quantities and magnitudes, by the use of symbols, and the measuring, relations, and properties of such quantities and magnitudes.

Algebra: The branch of mathematics which uses letters and other symbols instead of actual numbers and quantities for calculations.

Trigonometry: The study of triangles, and various relations of sides and angles of triangles.

Arithmetic: The branch of mathematics in which we use figures for calculations.

Boolean: Pertaining to, or described by an abstract system of postulates and symbols applicable to logical problems.

Algebra: The part of mathematics that uses letters and other symbols instead of actual numbers and quantities for calculations.

Logic circuit (or Logic gate): i) An electronic circuit that can be used to perform simple logical operations.

ii) An electronic circuit designed to perform a particular logical function based on the concepts of "and", "either-or", "neither-nor", etc. Normally these circuits operate between two discrete voltage levels, i.e. high and low logic levels, and described as binary logic circuits.

Electronic circuit: A combination of electronic components that form a conducting path.

OR gate: A circuit with two or more inputs and one output whose output is high if any one or more of the inputs are high. Mathematical notation is: $X = A + B$

AND gate: A circuit with two or more inputs and one output in which the output signal is high if and only if all the inputs are high simultaneously. Mathematical notation is: $X = A \cdot B$

NOT gate (or Inverter): A circuit with one input whose output is high if the input is low and vice versa. Mathematical notation is: $X = \overline{A}$

NOR gate: A circuit with two or more inputs and one output, whose output is high if and only if all the inputs are low. Mathematical notation is: $X = \overline{A + B}$

NAND gate: A circuit with two or more inputs and one output, whose output is high if any one or more of the inputs is low, and low if all the inputs are high.

Mathematical notation is: $X = \overline{A \cdot B}$

Exclusive OR gate(XOR): A circuit with two or more inputs and one output whose output is high if any one of the inputs is high. Mathematical notation is:

$$X = A\overline{B} + \overline{A}B$$

Exclusive NOR gate(XNOR): A circuit with two or more inputs and one output, whose output is high if two inputs are identical and low when two inputs are different. $X = AB + \overline{A}\,\overline{B}$

Monitor: A device that observes and records selected activities within a system for analysis.

Parameter: A quantity that is constant in a given case but takes a particular value for each case considered.

Sensor: A device which detects or measures some condition or property and records, indicates, or otherwise responds to the information received.

Light dependent resistance (LDR): Such resistance whose value depends upon the intensity of light falling upon it.

Thermister: A semiconductor device that has a large negative temperature coefficient of resistance, and can be used for temperature measurement, or as a controlling element in electronic control circuits.

Vat: A tub, tank, cask, or other large vessel used to hold a liquid.

Dawn of Modern Physics (Chap 19)

Modern Physics: New Physics which is more general and more basic than the Newtonian Physics.

Classical Physics (or Newtonian Physics): The part of Physics that was developed before, and therefore does not include, either quantum theory or the theory of relativity.

Black body (or Full radiator): A body that absorbs all the radiation falling on it.

Black body radiation: The thermal radiation from a black body at a given temperature, having a spectral distribution of energy with some specific characteristics.

Photoelectric effect: The emission of electrons by a substance when illuminated by electromagnetic radiation.

Quantum theory: According to it the radiant energy of a system or the exchange of radiant energy between different systems occurs not in a continuous fashion permitting all possible values, as demanded by the wave theory but in a discrete quantified form, as integral multiples of an elementary quantum of energy.

Theory of relativity: A theory formulated by Einstein, that recognizes the impossibility of determining absolute motion and leads to the concept of a four-dimensional space-time continuum.

Special theory of relativity: The part of relativistic mechanics as developed by Einstein which pertains to uniform motion.

General theory of relativity: The part of relativistic mechanics as developed by Einstein, which pertains to accelerated motion.

Electromagnetic radiation (or Electromagnetic waves): Transverse waves in space having an electric component and a magnetic component, each being perpendicular to each other and both perpendicular to the direction of propagation. These do not require any medium for its motion.

Globe: A spherical representation of our planet the earth.

Coordinate: One of the quantities used to define the position of a point relative to a frame of reference. There are three main coordinate systems.

Cartesian coordinate system: Three mutually perpendicular lines/axis are drawn through a point O known as the origin.

Cylindrical polar coordinates: The position of a point P is specified by three coordinates: radial distance r, azimuthal angle θ , and axial distance z, these being related to the Cartesian system by

$$x = r\cos\theta, \quad y = r\sin\theta, \quad z \equiv z$$

Spherical polar coordinates: The coordinates of P are the radius r, the azimuthal angle θ, and the angle of longitude ϕ. These are related to the Cartesian system by

$$x = r\sin\theta\cos\phi, \; y = r\sin\theta\sin\phi, \; z = r\cos\theta$$

Frame of reference: A coordinate system in which measurements are made.

Inertial frame of reference: A frame of reference in which law of inertia holds.

Accelerated frame of reference: A frame of reference in which law of inertia does not hold.

Law of inertia (or 1st law of motion): A body at rest remains at rest unless an unbalanced force produces acceleration in it.

Ether: A hypothetical fluid, formerly thought to permeate all space and to be the medium through which electromagnetic waves were propagated.

Absolute motion (or velocity): Velocity (or motion) measured relative to hypothetical medium ether.

Absolute rest: The state of a body in which its position with respect to hypothetical medium ether does not change.

Relative velocity: The vector difference of the two velocities.

Relativistic velocity: Any velocity that is sufficiently high to make the mass of an object significantly greater than its rest mass.

Uniform motion: Motion of a body with equal distances in equal intervals of time.

Time dilation: Time is not absolute, but depends upon the motion of the frame of reference according to the equation,

$$t = \frac{t_o}{\sqrt{1 - v^2 / c^2}}$$

Length contraction: In relative motion, length of two points fixed distance apart, appears shorter length than if we are at rest relative to them, it is according to the equation,

$$l = l_o \sqrt{1 - v^2 / c^2}$$

Mass variation: The mass of an object is a varying quantity and depends upon the speed of the object. They are related by,

$$m = \frac{m_o}{\sqrt{1 - v^2 / c^2}}$$

Energy-mass relation: Mass and energy are different entities but are interconvertible, according to the equation,

$$E = m c^2$$

NAVSTAR GPS: Formally known as the Navstar Global Positioning System, was initiated in 1973. it is joint service effort directed by the United States Department of Defense. Navstar GPS is a space-based radio-positioning system consisting of 24 orbiting satellites that provide navigation and timing information to military and thousands of civilian users worldwide. It is based on Einstein's theory of relativity.

Navigation: The art or science of directing a ship, boat, or aircraft, spacecraft, etc.; any of several methods of determining or planning a craft's position and course by geometry, astronomy, etc.

Radiation: Emission of energy from the surface of a body in the form of electromagnetic waves.

Black body radiation: The thermal radiation from a black body at a given temperature, having a spectral distribution of energy with some specific characteristics.

Cavity: A hollow place; a hollow; an empty space in a solid body.

Black body (or Cavity radiator): A substance that absorbs completely radiations of all frequencies, and can also emit radiations of all frequencies.

Cavity absorber: A device that may take the form either of a narrow tube or cavity through which sound is passed, or a hollow resonator placed in the sound field.

Radiator: A thing that radiates something, especially, light, heat, or sound waves.

Stefan's law: Former name of Stefan-Boltzmann law.

Stefan-Boltzmann law: The total amount of heat radiated by a perfectly black body per second per unit area is directly proportional to the fourth power of its absolute temperature; $E = \sigma T^4$

Stefan's constant: Former name for Stefan-Boltzmann constant.

Stefan-Boltzmann constant: The constant σ in Stefan-Boltzmann law, equal to

$$\sigma = 2\pi^5 k^4 / 15 h^3 c^2$$

Nobel prize/laureate: A fund of $ 9 million was set up. The interest of which is annually distributed among six important discoveries or inventions in Physics, Chemistry, Medicine, Literature, Economics, and for peace among nations. It is according to will of Alfred Bernhard Nobel (1833 -1896)

Quantum (plural **Quanta):** The smallest amount of energy that a system can gain or lose.

Photon: The basic energy packet of electromagnetic radiation.

Granular: Consisting of grains or granules. Having a granulated surface or structure.

Electromagnetic spectrum: Complete array of known electromagnetic radiations.

Radio waves (or Radio frequency): The frequency of electromagnetic radiation within the range used in radio, i.e. from $3x10^7$ to $3x10^9$ Hz.

Electromagnetic radiation (or Electromagnetic waves): Transverse waves in space having an electric component and a magnetic component, each being perpendicular to each other and both perpendicular to the direction of propagation. These do not require any medium for its motion.

Photoelectric effect: The emission of electrons by a substance when illuminated by electromagnetic radiation.

Monochromatic light (or Monochromatic): Light consisting of only one colour.

White light: Light such as day light, containing all wavelengths of the visible spectrum at normal intensities so that no colouration is apparent.

Photoelectrons: Electrons emitted from a light sensitive material when it is properly illuminated.

Photoelectric current: The current flowing in a material due to photoelectrons.

Threshold frequency (ν_o): Minimum frequency required for a photon of radiation to remove an electron from the surface of a material.

Stopping potential: Voltage corresponding to the maximum energy of the photoelectrons.

Classical theory: The part of physics that was developed before, and therefore does not include, either quantum theory or the theory of relativity.

Threshold frequency: Minimum frequency required for a photon of radiation to remove an electron from the surface of a material.

Quantization of energy: According to it, light energy is emitted or absorbed in small packets of energy , called quantum of energy. These quanta are known as photons.

Work function: The minimum energy required to remove an electron from the surface of a material and send it into field-free space.

Einstein's photoelectric equation: An equation which relates maximum energy of the photoelectrons to the frequency of incident light; mathematically,

$$\tfrac{1}{2} m v_o^2 = h\nu - \phi_o$$

Newton's corpuscular theory: According to it light consists of streams of minute particles in motion.

Huygen's wave theory: According to it light travels from one place to another in the form of waves.

Electromagnetic wave theory: According to it light waves are electromagnetic in nature and they consists of an oscillating electric field and an oscillating magnetic field, both are perpendicular to each other and have the same frequency and phase.

Quantum theory of light: According to it light is carried from one place to another in wave packets called 'quanta' or 'photons', each having a definite energy and momentum.

Photocell: Any device for producing an electric signal from electromagnetic radiation.

Cutoff wavelength: In an electrical network, possessing no internal source of energy, the wavelength at which the attenuation quickly changes from a small value to a much higher value.

Compton effect: The phenomenon in which a photon is scattered by an electron and the scattered photon has a frequency less than its original frequency.

Photon: i) The basic energy packet of electromagnetic radiation.
ii) A quantum of electromagnetic radiation that has zero rest mass, and energy equal to the product of the frequency of the radiation and Planck's constant.

Scattering: The 'spreading out' of a beam of radiation as it passes through matter, reducing the energy moving in the original direction.

Compton shift: The change in wavelength of the scattered photon. This Compton shift depends only upon the scattering angle and is independent of the frequency of the incident photon.

Pair production (or Materialization of energy): When high energy radiations, like cosmic rays, γ-rays, are absorbed by matter, under certain conditions, there is production of material particles, the electron-positron pair.

X-rays (or Inverse photoelectric effect): i) The emission of photons of radiations due to the bombardment on a material with high speed electrons.
ii) Electromagnetic radiation of extremely short wavelength, having great penetrating power.

Annihilation of matter: The process in which positrons and electrons unite to be annihilated as material particles and produce radiant energy.

Antiparticle: A counterpart of a subatomic particle having the same properties but opposite charge and spin direction.

De Broglie wave: A wave associated with a particle, such as an electron or proton.

De Broglie relation (or equation): A particle of mass *m* moving with a velocity *v* will under suitable experimental conditions exhibit the characteristics of a wave of wavelength λ given by the equation $\lambda = h / mv$, where h is the Planck constant.

Diffraction: The bending ore spreading of waves around the edge of an opening or obstacle.

Interference: The phenomenon in which the two waves support each other at some points and cancel at others.

Wave particle duality: The phenomenon whereby electromagnetic radiation and particles can exhibit either wave-like or particle-like behaviour, but not both.

Principle of complementarity: That both wave and particle aspects are required for the complete description of both radiation and matter.

Electron microscope: An apparatus for producing a magnified image by using a beam of electrons focused by electron lenses.

Optical microscope: Ordinary microscope; a device for producing large images of close small objects with a set of lenses. Light is directed onto the object through the lenses.

Resolution: Ability to distinguish two close objects separately, rather than as one single object.

Heisenberg uncertainty principle: It is impossible simultaneously to determine exactly both the position of an object and its momentum.

Planck's constant: A universal proportionality constant relating photon energy to the frequency of radiation; 6.6256×10^{-34} Jsec.

Subatomic: A constituent part of an atom, a subatomic particle, e.g., electrons, protons and neutrons. Occurring in the atom; smaller than an atom. Also, dealing with or involving particles, forces, or phenomena on this scale.

Atomic Spectra (Chap 20)

Spectroscopy: Branch of physics deals with the production and analysis of spectra.
Absorption spectrum: A continuous spectrum interrupted by dark lines or bands which appear at points where absorbed frequencies would normally occur.
Emission spectrum: The spectrum observed when electromagnetic radiation coming directly from an incandescent source is examined with a spectroscope.
Molecular spectrum: The absorbed or emission spectrum that is characteristic of a molecule.
Continuous spectra: The spectra consisting of a wide range of unseparated wavelengths.
Line spectra (or Discrete spectra): Spectra consisting of monochromatic slit images having wavelengths characteristic of the atoms present.
Band spectra: The spectra that appear as a number of fluted bands of colour of emitted or absorbed radiation.
Solar spectrum: The band of colours produced when sunlight is dispersed by a prism.
Pure spectrum: The spectrum in which each colour of the light will form a separate sharp image of the narrow slit.
Elementary colours: The six regions of colour in the solar spectrum, observed by the dispersion of sunlight; red, orange, yellow, green, blue, and violet.
Black body radiation: The thermal radiation from a black body at a given temperature, having a spectral distribution of energy with some specific characteristics.
Spectrum: i) The set of colours obtained on the screen by dispersion.
ii) Array of colours arranged according to their wavelength.
Spectrometer: Optical instrument used for the study of spectra. It consists of collimator, turntable and telescope.
Collimator: The part of the spectrometer consisting of slit and a convex lens, which is called collimating lens.
Turn-table: The part of the spectrometer between collimator and telescope. This turntable is provided with three leveling screws. It is used for supporting the prism or the diffraction grating.
Telescope: A device for collecting and producing an image of distant objects.
Diffraction grating (or Grating): An optical surface, either transmitting or reflecting with several thousand equally spaced and parallel lines ruled on it.
Line spectrum: A spectrum consisting of monochromatic slit images having wavelengths characteristic of the atoms present.
Rydberg's constant: A constant relating to those atomic spectra that are similar to the hydrogen atom spectrum. For hydrogen, it is 1.09677×10^{-7} m. The general Rydberg formula is;

$$1 / \lambda = R (1 / p^2 - 1 / n^2)$$

Balmer series: The visible spectrum of hydrogen. It consists of sharp distinct lines corresponding to second lowest energy level.
Lyman series: A series of lines that occurs in the ultra-violet region of the spectrum of hydrogen, corresponding to lowest energy level.
Ultraviolet region: The region just beyond the violet end of the visible spectrum. Its range is between about 1 nm and 400 nm.
Infrared region: The region past the red end of the visible spectrum. The range of wavelengths is approximately 0.7 μm to 1 mm.
Paschen series: A series of lines that occurs in the infra-red regio0n of the spectrum of hydrogen.

Brackett series: A series of lines that occurs in the far Ingra-red region of hydrogen spectrum. They correspond to the atomic electrons falling into the fourth energy level and emitting energy as radiation.

Pfund series: A series of lines that occurs in the far infra-red region of hydrogen spectrum. They correspond to the atomic electrons falling into the fifth energy level and emitting energy as radiation.

Planck's quantum theory: i) According to it the radiant energy of a system or the exchange of radiant energy between different systems occurs not in a continuous fashion permitting all possible values, as demanded by the wave theory but in a discrete quantified form, as integral multiples of an elementary quantum of energy.

ii) A unified theory which assumes that the transfer of energy between light radiations and matter occurs in discrete units, the magnitude of which depends on the frequency of the radiation.

Classical theory: i) The long established part of physics excluding relativity and quantum theories.

ii) The part of physics that was developed before, and therefore does not include, either quantum theory or the theory of relativity.

Postulate: A statement which is taken for granted as a fact ; to assume without proof.

Hypothesis: A theory, which may or may not prove to be true.

Law: A scientific statement of the action and relation of things in nature, observed to be always the same under given conditions with the same result performed anywhere in the world.

Principal quantum number: An integral multiple, n, for allowed stationary orbits in Bohr's atom model. It takes only integral values 1, 2, 3, ……, n.

Spectroscopy: Branch of physics deals with the production and analysis of spectra.

Ionization: The process of producing ions.

Ionization energy (or Ionization potential): The energy required to remove an electron from an atom or molecule to form a positive ion.

Binding energy: i) The energy needed to break up a nucleus into its constituent particles.

ii) The energy equivalent to the difference between the mass of the nucleus and the sum of the masses of its constituent nucleons.

Ground state (or Normal state): The state of a system with the lowest energy. An isolated body will remain indefinitely init.

Excited state: The state of a system, such as an atom or molecule, when it has a higher energy than its ground state.

Excitation potential: The potential through which an electron should be accelerated so that, on collision it can lift the electron in the atom from its ground state to some higher state.

Transition: A sudden change in the energy state of an atom or nucleus between two of its energy levels.

Shell: The electrons with the same principal quantum number 'n' are said to form a shell.

Sub-shell: The electrons in each shell are arranged in subshells, specified by the value l (l = 0, 1, 2, …., n-1). In Bohr's theory n and l determine the size and shape of the orbit.

X-rays: Electromagnetic radiation of extremely short wavelength, having great penetrating power.

Characteristic X-rays: When X-rays are made to fall on the target material, and electrons in the inner most shells will be knocked out. The photons emitted from inner shell transitions are called characteristic X-rays, because their energies depend upon the type of target material.

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Cadmium ($_{48}Cd^{112}$)**:** A soft bluish metal, used in low melting point alloys to make solders in some batteries.

Bremsstrahlung (or Breaking radiation): X-rays emitted when fast electrons are slowed down violently, as when electrons strike the target in an X-ray tube. The word translates as 'breaking radiation'. Bremsstrahlung is caused when an electron passes through the electric field of a nucleus and constitutes the continuous X-ray spectrum.

CAT: Stands for 'Computerized axial tomography'.

Tomography: A method of radiography that focuses an organ or plane, thus eliminating the confusing shadow of the ordinary radiogram, which makes diagnosis so difficult.

CAT scanner: A computerized system for scanning shadow photographs of the internal structure of the body with direct focus on an organ to eliminate confusing shadow.

Susceptible: Capable of getting a disease, deficient in defences against a disease.

Radiography: The production of shadow photographs of the internal structure of bodies opaque to visible light by the radiation from X-rays, or by gamma-rays from radioactive substances.

Radiograph: The shadow photographs obtained in the process of radiography.

Scanning: The process of exploring an area or volume in a methodical manner, in order to produce a variable electrical output whose instantaneous value depends on the information contained in the small area examined at each instant.

Topography: The determination and description of the arrangement of parts in a region of the body, or of the external anatomy of an animal.

Tumour: An abnormal swelling or enlargement in any part of the body of an animal or plant; an excrescence. Usually a permanent swelling without inflammation, caused by excessive continued growth of cells in a tissue. .

Proteins: Any of a large group of organic compounds found in all living organisms. Proteins comprise carbon, hydrogen, oxygen and nitrogen also sulphur.

Genetic: Pertaining to, or involving origin; arising from a common origin· Sequences of nucleotides in chromosomal DNA or RNA, different groups of three consecutive nucleotides corresponding to different amino acids.

DNA (Deoxyribonucleic acid) **:** A nucleic acid containing a sugar component; a self-replicating material present in nearly all living organisms, esp. in chromosomes, as the carrier of genetic information and the determiner of protein synthesis, usually occurring as a molecular double helix in which a phosphate group alternates with a sugar molecule linked to a base.

Chromosome: A threadlike structure of nucleic acids and protein which carries a set of linked genes and in characteristic numbers, usually paired, in the cell nuclei of higher organisms.

RNA: Any of the nucleic acids which yield sugar on hydrolysis, occurring chiefly in the cells, where they direct the synthesis of proteins, and as the genetic material in some viruses.

Cancer cells (or Cancer): A malignant tumour or growth of body tissue that tends to spread and may recur if removed; disease in which such a growth occurs.

Malignant: .A disease liable to become progressively more severe; extremely virulent; very infectious. Now chiefly of a cancer or tumour: tending to spread to other parts of the body, or to recur after removal.

Anatomy: The science of the structure of the bodies of humans, animals, and plants; a treatise in this field.

Anatomical: Of or pertaining to the study or practice of anatomy; structural.

Laser: (*L*ight *A*mplification by *S*timulated *E*mission of *R*adiation); a device which is able to produce a beam of radiation with unusual properties, generally the beam is coherent, monochromatic, parallel with high intensity.

Maser: (*M*icrowave *A*mplification by *S*timulated *E*mission of *R*adiation); a device for producing an intense source of coherent microwave radiation. Masers, like lasers, operate by population inversion and stimulated emission.

Acronym: A word formed from the initial letters or parts of other words; *loosely* an abbreviation composed of initial letters.

Stimulate: To rouse and produce greater activity in.

Monochromatic: Light consisting of only one colour.

Coherent: Having same phase, i.e. peaks and troughs always come together.

Phase coherence: Producing of two waves at the same instant, having same wavelength and time period.

Intensity: The energy transmitted per second through a unit area by the light waves.

Stimulated (or Induced) absorption: Absorption of incident photon by an atom in the ground state, thereby leaving the atom in the excited state.

Stimulated (or Induced) emission: The incident photon of energy induces the atom in excited state, to decay by emitting a photon that travels in the direction of the incident photon, to get unidirectional coherent beam.

Metastable state: i) It is an excited state in which an electron spontaneously falls to lower state only after relatively longer time.
ii) A condition of a system or body in which it appears to be a stable equilibrium but, if disturbed, can settle into a lower energy state.

Population inversion: A net emission of photons with more number of atoms in the excited state than in the ground state.

Organelle: Any of various specialized structures in the material of an individual cell or unicellular organism, analogous to the organs of multicellular organisms.

Retina: The inner, sensitive coating of the eye containing the ends of the nerves of sight; that part of the eye which receives images of object.

Iris: The circular coloured membrane of the eye.

Pupil: The opening in the iris of the eye, through which rays of light pass to the retina.

Lymph: A colourless fluid in plants; A colourless alkaline fluid, resembling blood but lacking red cells, which bathes various tissues and organs of the body and drains into the bloodstream through a network of vessels.

Optical fibre: An optical fibre consists of a single flexible rod of high refractive index, less than 1mm in diameter, having polished surfaces coated with transparent material of lower refractive index.

Refractive index (or Absolute index of refraction): The ratio of velocity of light in vacuum to its velocity in a given substance.

$$n = c_1 / c_2$$

Holography: A method of recording, usually photographically, a three-dimensional image of an object.

Ophthalmology: The branch of medicine that deals with the structure, functions, and diseases of the eye.

Nuclear Physics (Chap 21)

Nuclear Physics: The branch of Physics that is concerned with nuclear structure, properties, and reactions, and their applications, e.g., in producing nuclear power or using radioisotopes.

Atom models: Several theories have been successively proposed, called atom models. Thus we have the Thomson atom model, Rutherford nuclear atom model, Bohr atom model, Sommerfeld's atom model, and Vector atom model.

Thomson atom model: According to this model, atom has a uniform density, there is no empty space inside the atom and the electrons are in stable equilibrium with the positive charges.

Rutherford nuclear atom model: He proposed that the mass and positive charge of the atom were not distributed uniformly over the volume of the atom, but instead were concentrated in an extremely small region at center of atom.

Bohr atom model: According to it, the electron revolves in a circular orbit around the nucleus, when moving in the allowed orbits does not radiate energy. Emission or absorption occurs when an electron makes transition from one orbit to another.

Sommerfeld's atom model: He gave the idea that electrons move in elliptical path and nucleus must lie at one of the focus. And two coordinates which varies periodically, namely the radius vector and the angle that the radius vector makes with the X-axis.

Vector atom model: The vector representation of the orbital model is called vector model.

Atom: The smallest particle of an element that can exist either alone or in combination with others of the same or of another element.

Nucleus (or Atomic nucleus): The positively charged dense central part of an atom.

Atomic number (or Charge number, or Proton number): The number of protons in the nucleus of an atom.

Mass number (or Nucleon number): i) The sum of the number of protons and neutrons in the nucleus of an atom.

ii) Nearest integer to its mass when measured in atomic mass units.

Nucleon: A particle found in the nucleus of atoms, i.e., a proton or a neutron.

Electron: Elementary particle of negative charge(-1.602 C) and rest mass 9.1096×10^{-31} kg.

Proton: An elementary particle of positive charge (+1.602 C) and rest mass 1.673×10^{-27} kg.

Neutron: An elementary neutral particle having a rest mass of 1.6749×10^{-27} kg.

Neutron number: The number of neutrons in the nucleus of an atom.

Periodic table: A table of elements arranged in order of increasing proton number to show the similarities of chemical elements with related electronic configurations.

Isotopes: Atoms of same atomic number but different mass number.

Ion: A charged particle consisting of an atom, or group of atoms, that has either lost or gained electrons.

Deuterium: Element whose atoms consist of deuterons.

Deuteron: Atomic nucleus consisting of one proton and one neutron.

Tritium: Triple heavy hydrogen composed of atoms having tritons as nuclei.

Triton: Radioactive hydrogen nucleus composed of one proton and two neutrons.

Neutrino: One of the fundamental particles of matter of zero mass and zero charge.

Meson: One of the fundamental particles of matter found with a positive, negative, or zero charge and with a mass from 210 to 1000 times that of the electron.

Xenon ($_{54}Xe$)**:** A colourless odourless gas belonging to group 0 of the periodic table. It is present in the atmosphere from which it is extracted by distillation of liquid air. The element is used in fluorescent lamps and bubble chambers.

Caesium ($_{55}Cs$)**:** A soft silvery white metallic element. Cs^{133} is the natural isotope. Cs^{137} is used as a γ - source. It has the lowest ionization potential of all elements, hence it is used in photoelectric cells.

Mass spectrograph: An apparatus for the determination of the exact masses of atomic particles, by photographing the mass spectrum produced, which obtains through suitably disposed magnetic and electric fields.

Mass spectrum: A spectrum obtained with a mass spectrometer or spectrograph in which a beam of ions is arranged in order of increasing charge to mass ratio.

Mass spectrometer: An apparatus for obtaining the mass spectrum of a beam of ions by means of suitably disposed magnetic and electric fields.

Mass defect (or Mass deficit): The arithmetic difference between the mass of a nucleus and the larger combined mass of its constituent particles.

Binding energy (of a nucleus): i) The energy needed to break up a nucleus into its constituent particles.
ii) The energy equivalent to the difference between the mass of the nucleus and the sum of the masses of its constituent nucleons.

Radioactive: Describing an element or nuclide that exhibits natural radioactivity.

Radioactivity: The spontaneous, uncontrollable decay of an atomic nucleus with the emission of particles and gamma rays.

α-particles: A helium nucleus emitted from the nucleus of a radioactive atom.

β-particles: Electron emitted from the nucleus of a radioactive atom.

γ-rays: High energy electromagnetic wave emitted from the nucleus of a radioactive atom.

Nuclear reaction: A reaction within atomic nucleus resulting a change in the identity of the nuclei.

Nuclear transmutation: A change in the atomic number of an atom.

Nuclear change: A change in the identity of atomic nuclei.

Radioactive decay: The spontaneous disintegration of unstable (radioactive) nuclei to give other a lighter more stable nuclei, accompanied by the emission of particles and/or photons.

α-decay: A type of radioactive decay in which the unstable nucleus emits a helium nucleus.

β-decay: A type of radioactive decay in which a nucleus emits, for instance, an electron.

γ-decay: A type of radioactive decay in which γ-rays are emitted by the specimen.

Decay constant (λ): The ratio between the number of nuclei decaying per second and the total number of nuclei.

Activity (A): For a radioactive substance, the average number of atoms disintegrating per unit time. Mathematically ; $A = \Delta N / \Delta t$

Curie: A unit of radioactivity, equivalent to the amount of a given radioactive substance that produces 3.7×10^{10} disintegrations per second.

Parent element: A given nuclide that undergoes radioactive decay to another specified nuclide, called the daughter element.

Daughter element: A given nuclide produced by radioactive decay from another nuclide, the parent element.

Radioactive series: A series of radioactive nuclides, each being formed by the decay of the previous one.

Radioactive dating: Any method for measuring the age of materials that depends on radioactivity.

Carbon-dating (or Radio-Carbon dating): It is a method of determining the age of objects up to 35000 years old containing matter that was once living, such as wood. Based on C^{14} radioactive decay and measuring its half life. .

Protactinium ($_{91}Pa^{231}$)**:** A radioactive metallic chemical element, which is a member of the actinide series and occurs as a decay product in uranium ores.

Statistics: i) The field of study that involves the collection and analysis of numerical facts or data of any kind.

ii) The statistical description appropriate to the behaviour and properties of an ensemble of many atoms, molecules, etc., esp. as regards the distribution of energy among them

Half life: Time required to decay an element into half of its original quantity.

Artificial radioactivity: When high energy particles are bombarded on the stable nuclides, the nuclides after becoming unstable disintegrates with the emission of radiation.

Iodine($_{53}I$)**:** A dark violet nonmetallic element. There is one stable isotope, I^{127} , and fourteen radioactive isotopes. It is insoluble in water but soluble in ethanol and other organic solvents. It is required as a trace element by living organisms. It is used in medicine as a mild antiseptic.

Range of the particle: Distance traveled by a particle in a medium before coming to rest, after emission from a unstable nuclide.

Solid: The state of matter that has definite volume and definite shape.

Liquid: The state of matter that has definite volume, but no definite shape.

Liquefaction: The production of a liquid from matter in another physical state.

Gas: The state of matter that has neither definite volume nor shape.

Ideal gas: A theoretical gas consisting of infinitely small molecules which exert no forces on each other.

Scattering: The 'spreading out' of a beam of radiation as it passes through matter, reducing the energy moving in the original direction.

Absorption: A process in which a gas is taken up by a liquid or solid, or in which a liquid is taken up by a solid.

Lambert's law: The law concerns the rate of absorption of radiation as it travels deeper into a medium. It states that equal thickness of the medium absorb equal proportions of the incident radiation. In other words, the intensity I of the transmitted radiation falls off exponentially with distance *x* in the medium:

$$I = I_o \, e^{-\mu x}$$

where I_o is the intensity of the initially incident radiation, and μ is the linear absorption coefficient of the medium.

Linear absorption coefficient: The coefficient μ in the Lambert's law. It depends upon the energy of the photon and the properties of the medium. It varies with wavelength.

Fluorescence: i) It is the property of absorbing radiant energy of high frequency and re-emitting energy of low frequency in the visible region of electromagnetic spectrum.

ii) A type of luminescence in which the emission of electromagnetic radiation ceases as soon as excitation ceases.

Detector: A device that responds to any physical effect, used to indicate the presence of a signal or to measure it.

Radiation detectors: The devices which detect atomic particles, such as, α-particle, β-particles, fast moving protons, γ- rays, etc.

Wilson-cloud chamber (or Cloud chamber): An apparatus used to detect the passage of charged atomic particles by the tracks visible as a row of droplets, form in a special chamber.

Geiger counter (or Geiger-Muller counter): Instrument used for the detection and measurement of radioactivity. It is gas-filled radiation detector operated at high voltage in which the gas amplification effect produces a large discharge pulse after each primary ionizing event.

Geiger-Muller tube: Discharge tube that is activated by the passage of ionizing particles or rays.

Solid state detector (or Semi-conductor detector): It consists of a semiconducting crystal in which electrons are not free to move, even though a voltage is applied through the crystal provides mobile electrons which are collected by the wires that apply the external voltage. Then the electrical pulse is amplified.

Supersaturated vapour: A vapour, the pressure of which exceeds the saturation vapour pressure at that temperature. It is unstable and condensation occurs in the presence of suitable nuclei or surfaces.

Vapour: A gas at any temperature at which it may be liquefied by pressure alone; i.e. a gas below its critical temperature.

Vapour pressure: The pressure exerted at a particular temperature by a vapour.

Adiabatic expansion: Spreading out or expanding of the gas in which not heat flows into or out of the system.

Erratic: Irregular or uncertain in movement; having no fixed course or direction.

Mica: A mineral consisting of complex silicates, characterized by a perfect separating along a line of natural splitting enabling the crystals to be split into very thin plates.

Cascade: A falling stream of something. A waterfall.

Scaler: A device that produces an output pulse when a specified number of input pulses have been received. It is usually used for counting purposes.

Quenching: The process of preventing a continuous discharge in a Geiger counter so that the incidence of further ionizing radiation can cause a new discharge.

Quenching gas: A gas or vapour such as ether or a halogen gas is introduced into the tube of Geiger counter to prevent a continuous discharge.

Nuclear reaction: A reaction within atomic nucleus resulting a change in the identity of the nuclei.

Reactants: In a nuclear reaction, fast moving particle and target nucleus are called reactants.

Products: In a nuclear reaction, the newly obtained particle and the recoil nucleus are called products.

Paraffin: A whitish translucent waxy combustible solid consisting of a mixture of hydrocarbons, obtained as residue from the distillation of petroleum and used esp. in candles, cosmetics, and polishes, and for coating and sealing.

Nuclear fission (or Fission reaction): The splitting of a heavy nucleus into nuclei of medium mass, with the release of nuclear energy.

Fission chain reaction: A continuing process of nuclear splitting

Critical mass: The minimum mass of a material that can sustain a nuclear chain reaction.

Critical volume: The volume occupied by the mass of a material that can sustain a nuclear chain reaction.

Atomic bomb (or Atom bomb): A bomb in which the explosion is caused by a fast uncontrolled fission reaction.

Cadmium ($_{48}Cd^{112}$) **:** A soft bluish metal, used in low melting point alloys to make solders in some batteries.

Nuclear reactor (or Atomic reactor): i) A device in which the controlled fission of radioactive material produces new radioactive substances and energy.
ii) A device in which nuclear reactions take place on a large scale.

Nuclear power station: A power station using a nuclear reactor as the source of energy.

Power station (or Generating station): A complete assemblage of plant, equipment, and the necessary buildings at a place where electric power is generated on a large scale.

Thermal power station: A power station using furnace as the source of energy.

Fission fragments: In a nuclear fission reaction, the product nuclei are called fission fragments.

Hydrocarbon: Chemical compounds that contain only carbon and hydrogen.

Moderator: A substance used in nuclear reactors to reduce the speed of fast neutrons produced by nuclear fission.

Heavy water (D_2O)**:** Deuterium oxide is called 'heavy water'; it is used as a moderator and coolant in some types of nuclear reactors.

KANUP (Karachi Nuclear Power Plant)**:** Here heavy water is used as a moderator, and transportation of heat, from reactor core to heat exchanger, also heavy water is used.

Nuclear waste: Used fuel in a nuclear reactor. Nuclear fuel once used for charging, keep on operation for few months, then fissile material begins to decrease. Then this used fuel is removed, which is still radioactive and injurious and harmful to the living things.

Dumping: To throw down nuclear waste in the bottom of old salt places, thousands of meters below the surface of the Earth.

Contaminate: Make impure by contact or mixture; pollute, corrupt, infect. Subject to contamination by radioactivity

Fast reactors: The types of fast reactors are research reactors, plutonium reactors, and breeder reactors.

Thermal reactors: The types of thermal reactors are boiling-water reactor, pressurized-water reactor, and liquid-metal reactor.

Research reactor: In this reactor uranium rods are placed inside a block of graphite. Fast moving neutrons are from fission of U^{235} are slowed down by graphite.

Plutonium reactor: It is used to produce plutonium that can be used in the atomic bomb as a fissionable material. The reactor contained a critical mass of U^{238} .

Breeder reactor: It is one in which a fissionable material is produced at a greater rate than the fuel is consumed.

Power reactor (or Thermal reactor): A power reactor is a device to make use of the natural heat developed in a uranium reactor as source of huge power.

Boiling-water reactor: In it a stream of water circulates through the core. The heat turns the water to steam, which is then used to generate electricity.

Pressurized-water reactor (PWR): Here the heat is extracted in two-step process. Water circulates through the core under great pressure, to prevent its turning to steam. This hot water then in turn heats a second water system, which actually delivers steam to the turbine.

Liquid-metal reactor: The disadvantage of using water is that it has small heat capacity. A metallic medium would be much better for heat transfer. Liquid sodium could replace the pressurized water.

Reprocessing plant: There are two types of reprocessing plants; electromagnetic separator and gaseous diffusion plant.

Natural uranium: The element uranium naturally occurs in three isotopes which posses identical chemical properties. Wherever it is extracted it contains the three isotopes with $_{92}U^{238}$ at 99.3 %, $_{92}U^{235}$ at 0.7 % and $_{92}U^{234}$ less than 0.001 %.

Enriched uranium: The uranium with greater percentage of U^{235} then natural uranium. It is done with the help of reprocessing plants.

Electromagnetic separator: It is identical in principle to the mass spectrometer. And depends for its action simply on the fact the U^{235} and U^{238} ions have different ratios of charge to mass. Here a sufficiently large current is needed.

Mass spectrometer: An instrument for producing ions in a gas and analyzing them according to their charge/mass ratio.

Gaseous diffusion plant: Gaseous diffusion separator depends on the slight difference in diffusion rate of gases of different molecular weight. U^{235} and U^{238} are pumped through a porous barrier and thousands of stages are required for fractional enrichment of the light isotope.

Core: The part of a nuclear reactor that contains the fissile material.

Fusion reaction (or Nuclear fusion): A reaction in which light nuclei combine to form a nucleus with medium mass, with the release of nuclear energy.

Mass defect (or Mass deficit): The arithmetic difference between the mass of a nucleus and the larger combined mass of its constituent particles.

Binding energy (of a nucleus): i) The energy needed to break up a nucleus into its constituent particles.
ii) The energy equivalent to the difference between the mass of the nucleus and the sum of the masses of its constituent nucleons.

Hurl: A rush or swirl of water; rushing water. A noisy rush or fall, esp. of stones etc. down a slope. The action or an act of hurling; a violent throw or cast.

Hydrogen bomb: It consists of a fission bomb surrounded by a layer of hydrogenous material, such as lithium deuteride.

Neutron bomb (or Cobalt bomb): It is made by covering hydrogen bomb with metallic cobalt. When it is exploded, neutrons emitted react with cobalt cover and form Co^{60} which three hundred times powerful than radium.

Electromagnetic radiation: Transverse waves in space having an electric component and a magnetic component, each being perpendicular to each other and both perpendicular to the direction of propagation. These do not require any medium for its motion.

Cosmic radiation (or Cosmic rays): High energy particles, falling upon the Earth, apparently from beyond our solar system, consisting chiefly, if not entirely of charged particles.

Ozone (or Trioxygen) [O_3]**:** A colourless gas, soluble in cold water and in alkalis. Liquid ozone is dark blue in colour and is diamagnetic (O_2 is paramagnetic). It is produced in the stratosphere by the action of high-energy ultraviolet radiation on oxygen and its presence acts as a screen for ultraviolet radiation.

Ozone layer: The region of the upper atmosphere, at an altitude of 10 to 50 km (6 to 30 miles), containing significant amounts of ozone, which absorbs short ultraviolet light; *esp.* the region of maximum ozone concentration between 20 and 25 km (12 and 15 miles).

Vomiting: When sick, matter ejected from the stomach.

Troposphere: The lowest region of the atmosphere, extending to a height of between 8 and 18 km (5 and 11 miles) and marked by convection and a general decrease of temperature with height.

Stratosphere: The region of the atmosphere extending above the troposphere to a height of about 50 km (30 miles), in which in the lower part there is little temperature variation with height, and in the higher part the temperature increases with height. Formerly, the lower part of this region, up to a height of about 20 km.

Chlorofluorocarbons (CFC): Any of a group of exceptionally stable compounds containing carbon, fluorine, and chlorine (analogous to the hydrocarbons), which have been used esp. as refrigerants and aerosol propellants.

Aerosol: An ultramicroscopic particles' dispersion of a solid or liquid in a gas. The commonly used aerosol sprays contain an inert propellant liquefied under pressure.

Propellant: The inert compressed fluid in which the active contents in an aerosol container etc. are thrust out.

Toxic: Of the nature of a poison; poisonous.

Toxic smoke: The visible suspension of poisonous gases and other particles in air, due to given off by a burning or smoky vapour.

Biology: The science, which deals with the origin and life history of plants and animals including botany and zoology.

Biological: Pertaining to the science, which deals with the origin and life history of plants and animals including botany and zoology.

Becquerel (Bq): The Becquerel is the SI unit of radioactivity. 1 becquerel represents one disintegration, or other nuclear transformation, per second; 1Curie = $37x10^9$ Bq

Curie: A unit of radioactivity, equivalent to the amount of a given radioactive substance that produces 3.7×10^{10} disintegrations per second.

Gray (Gy): The SI unit of absorbed energy dose per unit mass resulting from the passage of ionizing radiation through living tissue. One gray is an energy absorption of one joule per kilogram of mass.

Sievert (Sv): An SI unit of dose equivalent of ionizing radiation, defined as that which delivers one joule of energy per kilogram of recipient mass, and equal to 100 rem.

Rad: A unit of absorbed dose of ionizing radiation, defined as being equivalent to an absorption of 10^{-2} joule of energy in one kilogram of material.

Rem (Roentgen equivalent man)**:** This unit is the quantity of ionizing radiation such that the energy imparted to a biological system per gram of living matter by the ionizing particles present in the locus of interest has the same biological effectiveness as one rad of 200 to 250 kilovolt X-rays.

Relative biological effectiveness (RBE): A quality factor to get the equivalent dose (D_e) of any absorbed radiation (D); $D_e = D \times RBE$

Diarrhea (or Diarrhoea) : A condition of excessively frequent and loose bowel movements. Also, watery /semi-liquid discharge characteristic of this condition.

Radiation sickness: Less than a lethal dose (400-600 rem) the victim complains nearly after six hours of nausea, loss of appetite, vomiting and diarrhea. High doses (> 2000 rem) result in brain damage, fits, coma and death within few days of exposure.

Cataract: A condition of partial or complete opacity of the lens of the eye.

Anaemia: A deficiency of red blood cells or their haemoglobin, often causing paleness.

Haemoglobin (or Hemoglobin): Hemoglobin is a protein that carried by red cells. It picks up oxygen in the lungs and delivers it to the peripheral tissues to maintain the life of cells.

Leukaemia: Any of a group of very infectious and progressive diseases characterized by the gross overproduction of white blood cells , which accumulate and suppress other production of blood cells.

Chromosome: A threadlike structure of nucleic acids and protein that carries a set of linked genes and occurs singly in prokaryotes and in characteristic numbers, usually paired, in the cell nuclei of higher organisms.

Mutation: The action or process of changing; an alteration, a change.

Isotopes: Atoms of same atomic number but different mass number.

Radioisotope: A radioactive isotope of an element. Tritium, for example, is a radioisotope of hydrogen.

Biology: The science, which deals with the origin and life history of plants and animals including botany and zoology.

Fertilizer: Any material put in or on the ground, which contains plant food.

Mutation: The action or process of changing; an alteration, a change.

Chickpea: The seed of a dwarf pea, grown for food especially in Asia.

Pest: A fatal epidemic disease. A troublesome, or destructive insect which attacks crops, livestock.

Radioactive tracing: A method of tracing the course of an element through a biological, chemical, or mechanical system.

Radioactive tracers: Radio-isotopes used to trace the path or position of an element through a biological, chemical, or mechanical system.

Radioactive isotope: An isotope of an element that is radioactive.

Dosimeter: Any instrument or material used for measuring radiation dose.

Dosimetry: The measurement of radiation dose, the choice of method being determined by the quantity and quality of radiation delivered, the rate of delivery and the convenience.

Malignant: A disease liable to become progressively more severe; extremely virulent; very infectious. Now chiefly of a cancer or tumour: tending to spread to other parts of the body, or to recur after removal.

Tumor: An abnormal swelling or enlargement in any part of the body of an animal or plant; an excrescence. Usually a permanent swelling without inflammation, caused by excessive continued growth of cells in a tissue. .

Photosynthesis: The process in plants by which carbon dioxide is converted into organic compounds using the energy of light absorbed by chlorophyll, which in all plants except some bacteria involves the production of oxygen from water; any photochemical synthesis of a chemical compound.

Radioactive Tracers: A definite quantity of radioisotope introduced into a biological or mechanical system so that its path through the system and its concentration in particular areas can be determined by measuring the radioactivity with the detector.

Thyroid gland: The secreting organ in the upper part of the wind pipe of the voice organ in the body.

Hyperactive gland: The secreting organ with excessive function.

Liver: A large lobed glandular organ in the abdomen of vertebrate animals which secretes bile, detoxifies the blood, and is important in the metabolism and storage of major nutrients.

Radiotherapy: The use of beams of ionizing radiation, such as X-rays, energetic electrons, and the streams of gamma rays from the radioisotope cobalt-60, in the treatment of cancer.

Malignant tissue: A tissue liable to become progressively more severe; extremely virulent; very infectious. Now chiefly of a cancer or tumour: tending to spread to other parts of the body, or to recur after removal.

Encapsulate: Enclose in or as in a capsule.

Radiograph: The shadow photographs obtained in the process of radiography.

Radiography: The production of shadow photographs of the internal structure of bodies opaque to visible light by the radiation from X-rays, or by gamma-rays from radioactive substances.

Scanning: The process of exploring an area or volume in a methodical manner, in order to produce a variable electrical output whose instantaneous value depends on the information contained in the small area examined at each instant.

Kidney: Either of a pair of glandular organs of rounded shape with a shallow indentation on one side, situated in humans in the back of the abdominal cavity, which maintain the composition of the blood, removing waste nitrogenous and other matter and excreting it as urine.

Gravitational force: The mutual force of attraction between particles of matter.

Magnetic force: A force associated with the motion of electric charges.

Electric force: Force of attraction or repulsion between two un-like or like charged bodies.

Weak nuclear force: A short range nuclear force acting between nucleons and is responsible for the decay of nuclei.

Strong nuclear force: A short range attractive force acting between nucleons and holds nucleus together.

Microscopic: Very small; invisible without a microscope.

Microscopic level: The level or state of matter characterized by the actual properties of each individual elemental component. Quantum theory is typically an analysis of the microscopic state.

Macroscopic level: The level or state of matter characterized by the statistical properties of its components. Kinetic theory is an analysis of the macroscopic state.

Kinetic theory: A theory explaining physical properties in terms of the motion of particles.

Quantum theory: A mathematical physical theory originally introduced by Max Planck to explain the black body radiation from hot bodies, it deals with the mechanics of atomic and related systems in terms of quantities that can be measured.

Unification: A grand unification theory has been proposed which combine the strong and electroweak forces intro single framework.

Subatomic particles: A constituent part of an atom, i.e. electrons, protons and neutrons. Which are further made up of elementary particles.

Photon: A quantum of electromagnetic radiation that has zero rest mass, and energy equal to the product of the frequency of the radiation and Planck's constant.

Leptons: A group of elementary particles including the electron, the muon, and the neutrino. They are distinguished from hadrons by their type of interaction.

Hadrons: A group of elementary particles, subdivided into the baryons and the mesons. The hadrons are distinguished from the leptons by their type of interaction.

Elementary particles (or Fundamental Particles, or Sub-atomic Particles): Invisible particles from which all matter is composed.

Quarks: A type of hypothetical fundamental particle postulated to make up other elementary particles.

Mesons: Elementary particles that are more massive than electrons but lighter than protons and neutrons. Mesons are thought to be involved in the exchange forces between nucleons in the nucleus.

Background radiation: The low intensity radiation resulting from the bombardment of the earth by cosmic rays and from the presence of naturally occurring radionuclides in rocks, soil, air, building materials, etc. When measurements of radiation are being carried out a correction must be made for the background radiation.

Cosmic rays: High energy particles, apparently from beyond our solar system.

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Origin of few Physics words

Word	**From**	**Meaning**
Atom	atomos (Greek)	uncuttable
Ammeter	ampere-meter	
Astatine		unstable
Cosmic rays	cosmos (Greek)	the Universe
C	celeritas (Latin)	velocity
Electricity	electrics (Greek)	amber
Ferromagnetic	ferrum (Latin)	iron
Formaline	Formaldehyde	l
Francium	the native land of French Chemist, Mlle. M. Perey	
Fusion	synonymous with melting	
K	konstant- German spelling	constant
Light beam	Baum- German word for tree	
Leyden jar	University of Leyden, Netherlands	
Magnet	magnetism- a town in Turkey- Magnesia	
Physics	physiko (Greek) natural brief form of physical philosophy	
Pneumatics	mechanics of gases (Greek)- air	
Polonium	Madame Curie's native land	
Radiation	ray Latin word 'radius'	
Radium	intense radio-activity	
Radio wave	wave that radiate	
Transformer	that transforms volt-ampere relationship	
Technetium	artificial- first discovery from man-made nuclear reactions	
Virtual		as if

Energy Sources (Time Scale)

Human muscle: Prehistoric Solar energy : Prehistoric Fire wood : Prehistoric Lamps : Prehistoric Wind energy: estimated 4000 B.C. Animal muscle : 4000 B.C. Natural gas : 900 B.C. Water energy : 30 B.C. Coal : 1 B.C. Wind Mill : 600 A.D. Explosive : 900 A.D.	Steam energy : 1712 A.D. Coal gas (town gas) : 1792 Fossil-energy revolution : 1825 Petroleum industry : 1857 Electrical energy : 1881 Internal combustion engine (for automobile etc.) : 1885 Nuclear energy : 1942 Lasers : 1960 Costly energy (oil from different offshore sources) : 1973

Information Technology (Time Scale)

Maps & diagrams: 2400 B.C. (Mesopotamia) seals : 2700 B.C. (Mesopotamia) envelopes : 3600 B.C.(Mesopotamia) writing : 3500 B.C. (Mesopotamia) Egyptian hicroglyphics : 3000 B.C. alphabet : 1800 B.C. (Sinai) Chinese writing : 1500 B.C. (Shang) coins : 600 B.C. (Anatolia) paper : 100 A.D. (China) modern numerals : 680 (Southeastern Asia) priting : 700 (China) paper money : 910 (China) printing press : 1455 (Germany) photography : 1839 (France)	electric telegraph : esp. 1844 S. Morse (U.S.) telephone : 1878 (U.S.) punched-card data processing : esp. 1890 (U.S.) sound recording : esp.1901 (U.S.) radio : esp. 1901 (Italy) electronics : 1906 (U.S.) radio broadcasting boom :1922 (Worldwide) computer : 1943 (Britain) television boom : esp. 1950 (U.S.) holography : esp. 1963 (U.S.) communications satellite:esp.1965(U.S.) microprocessor : 1971 (U.S.) optical-fiber links:1980(various countries)

Resistor and Capacitor Colour Codes

Coloured bands around the body of a resistor designate the nominal value of its resistance in ohms. Three coloured bands grouped toward one end of the resistor, as shown in fig. 1, are interpreted as a number having two significant figures and a multiplier factor.

The band nearest the end of the resistor represents the first significant figure according to the colour code in the table. The second band in the second significant figure, and the third band gives the number of zeros to add to determine the actuial resistance. For example, a resistor whose bands are yellow, violet, and orange has a resistance of 47,000 Ω ; green, blue, and green signifies 5,600,000 Ω , or 5.6 M Ω etc. Resistor values between 1 and 10 Ω are indicated by a gold third band, while a silver third band means the resistance is between 0.1 and 1 Ω.

A fourth band of either gold or silver tells the tolerance, or limit of accuracy, of the resistance value. A gold band indicates the tolerance is ± 5 % , which means that the actual resistance may be any value within 5 % of the nominal value. Similarly, a silver band signifies a tolerance of ± 10 % . if the fourth band is absent the tolerance is understood to be ± 20 % .

Fig. 1

Table

Resistor Colour Code

Colour	Number
Black	0
Brown	1
Red	2
Orange	3
Yellow	4
Green	5
Blue	6
Violet	7
Gray	8
White	9

Capacitor colour codes are not universally accepted as is the case for resistors. The codes used differ somewhat among manufacturers and many manufacturers print the numerical value of capacitance on the body of the unit. Nevertheless, the majority of mica and ceramic tubular capacitors used the same colour code as in the Table above, to indicate the nominal capacitance value in picofarads, shown figure below. For example, red, violet, and red signifies 2700 pf or 0.0027 μf; orange, orange, black means 33 pf, etc. other coloured bands or dots are also used to indicate tolerance, temperature coefficient of capacitance, and parameters. These also vary from manufacturer to manufacturer.

Fig. 2

Colour-code scheme for mica (right) and ceramic (left) capacitors.

tolerance

first digit second digit multiplier tolerance

first digit second digit multiplier

first digit second digit multiplier

white or black
means mica