

Diploma in X-Ray & ECG Technology

Paper-II (General and Radiation Physics)

Unit-I: Units and measurements

Measurement of any physical quantity is a number and any idea about its magnitudes is given by its unit.

It consist of two parts Numeric value and physical quantity eg.-1.50(numeric) meter (physical quantity) is 1.50 M

Types-

- 1.- C.G.S (centimeter gram second)
- 2.- K.K.G (meter kilogram second)
- 3.- F.P.S (foot pound second)
- 4.- Indian old system
- 5.- S.I (International system of unit)

Motion- It is the change in position of the object when a force is applied on it.

Force - A force can cause an object with mass to change its velocity i.e. to accelerate.

It can also be describe intuitively as push or pull. It has both magnitude and direction making it is vector quantity.

--Its unit is Newton and it represent by the symbol F .

Work - It is the product of force and displacement.

-- A force is said to do work if when acting those is a movement of the point of application in the direction of the force.

Its S.I unit is Joule (J)

It is the quantitative property that must be transferred to an object in order to perform work or to heat the object.

-- It is a conserved quantity.

--Its S.I unit is Jule (J)

Heat- It is energy in transfer to or from a thermodynamic system by mechanism other than thermodynamic work or transfer of matter.

--It S.I unit is jule(J)

Acceleration – It is the rate of change of velocity of an object with respect to time.

-- It is a vector quantity

-- Its S.I unit is M/S^2 .

Velocity – The velocity of an object is the rate of change of its position with respect to a time.

--It is vector quantity

--Its S.I unit is Meter/Second or m/s.

Matter – It is any substance that has mass and takes up space by having volume.

--It is commonly of 3 types- Solid, Liquid and Gas.

Properties of matter- There are two types of its properties.

1. Physical property and
2. Chemical property

Physical property- Observed without changing its substance into something else.

Example- Color, density, shape, boiling pint, more.

Chemical property- observed only when substance is changed and interacts with another substance. Example- flam mobility (able to burn), rusting (combining with O₂ to form rust).



Unit 2: HEAT

Definition- It is the energy transfer to or from a thermo dynamic system by mechanism other than. Thermo- dynamic work or transfer of matter.

Types- Heat transfer is classified into various mechanisms such as- thermal conduction, thermal convection, and thermal radiation

Kinetic theory of heat- It states that molecules in a fluid increase their speed as temp r increases

--as the temp r keeps on increasing the inter molecules space between the matter molecules increases.

Methods of heat dissipation – It can be dissipate by 3 ways-

1.- Conduction- The process in which heat energy is transferred from one system to another system without visible motion of particles is called conduction. Mainly occurs in solids.

2 .- convection- the process in which heat energy is transferred form on e system to another system due to movement of particles through large distances. Mainly occurs in liquids.

3.- Radiation- Radiation is the form of energy which can travel from one place to another without any medium. In this method of heat dissipation, heat energy travels from one system to another in the form of electromagnetic waves with no need of material medium. Mainly occurs in gases.

Thermal Expansion – It is the tendency of matter to change its shape, area and volume in response to a change in temperature.

Thermionic Emission- It is the liberation of electrons from an electrode by virtue of its temperature

The charge carriers can be electrons or ions and in older literature are sometimes referred to as thermions.

After emission a charges that is equal in magnitude and opposite in sign to the total chare emitted is initially left behind in the emitting region.

Unit-3 Magnetism and Electromagnetic Induction

Magnet- Magnet is a material object that produces a magnetic field.

The word magnet in Greek word meant “Stone from magnesia “

Every magnet has at least one north and one South Pole.

Properties of Magnet-

- * Magnet attract object of iron, cobalt and nickel.
- * The force of attraction of a magnet is greater as its poles than in the middle.
- * Like poles of two magnets repel each other.
- * opposite poles of two magnets attracts each others.
- * Magnetic field originates from south and terminates at North Pole

Types of Magnet-

Permanent magnet- A magnet that retains its magnetic properties in the absence of an inducing field or current.

Temporary magnet- A magnet that stay magnetized only for a relatively short period of time in the presence of inducing field or current.

Magnetic field- A magnetic field is a vector field that describes the magnetic force influence of electric charges in relative motion and magnetized materials.

A charge that is moving parallel to a current of other charges experience a force perpendicular to its own velocity.

The effects of magnetic field are commonly seen in permanent magnets.

Magnetic Flux- it is a measure of the magnetic field strength present over a given area. Its unit is Weber (WB)

$$\Phi_B = B.A$$

Unit of Magnetism-

Unit of magnetic flux- weber
Unit of magnetic flux density tesla

Unit of inductance – Henry

Magnetic line of force- curved lines used to represent a magnetic field, drawn such that the number of lines relates to the magnetic field's strength at a given point and the tangent at any curve at a particular point is along the direction of magnetic force at that point.

It always begins from North Pole and ends on the south pole of the magnet.

They never cross each other.

The density decreases with increasing distance from the poles

Magnetic classification of matter- Depending on whether there is an attraction or repulsion by the pole of a magnet, matter is classified as either paramagnetic or diamagnetic respectively

--A few materials show a very large attraction toward the pole of a permanent bar magnet, materials of this kind are called ferromagnetic

Hysteresis – Magnetic hysteresis occurs when an external magnetic field is applied to a ferromagnet such as iron and the atomic dipoles align themselves with it.

--Even when the field is removed, part of the alignment will be retained, and the material becomes magnetized.

-- The magnetization of ferromagnetic substances due to a varying magnetic field lags behind the field. This effect is called hysteresis.

Electromagnetism- Branch of physics which deals with the electromagnetic force that occurs between electrically charged particles

Laws of electromagnetic induction-

Faraday 's Law- when a magnet moves part different materials the voltage induced is the same for each case.

--The most current will be produce in the material where the electrons are bound most loosely. i.e the magnet will produce a large current when moving part copper than rubber.



विद्यैव बलम्

Unit-4: Electricity

A fundamental form of energy observable in positive and negative form that occurs naturally and i.e expressed in terms of movement and interaction of.

Current- Electric current is defined as rate of flow of electric charge

$$I=Q/T \quad (I=\text{current}, Q=\text{Charge}, T=\text{Time})$$

--Its unit is Ampere A .

Charge-There are two types of charge positive and negative

If we rub glass rod with silk then the glass rod acquires the +ve charge and silk -ve charge because all the elements are made up of atoms.

Potential difference- It is the difference of charges between two points along a conductor

The difference in potential between two points is equal to the work required to move a charge of one coulomb between two points.

Capacitance and Capacitor- Capacitance is the capacity by virtue of which a capacitor can store charge in it. Capacitor is a device which stores charge for a temporary time period. It is an arrangement by which capacitance of a conductor is increased.

Working mechanism of Capacitor-Let us consider two conductors A and B placed at certain distance conductor A is having the +ve charge +q and conductor B as negative charge -q. These charges will be distributed on the surface of the conductors of the potential of conductor A as V_1 and at B as V_2 hence the potential difference- $V=V_1-V_2$

Resistance- It is the property of a substance by virtue of which it offers hindrance to the flow of charge.

Unit of resistance- The symbol of resistance is R and its unit is ohm.

Ohm's Law- It states that the electrical current 'I' flowing through a conductor is directly proportional to the potential difference V across its end, provided other physical condition remains same.

$$V=IR$$

Galvanometer- It is an electrical instrument used for detecting and indicating an electric current.

A galvanometer works as an actuator by producing a rotary deflection in response to electric current flowing through a coil in a constant magnetic field.

Voltmeter- It is an instrument used to measure potential difference b/w any two points of a conductor or in any part of a circuit.

Ammeter- It is used for measuring current in a circuit and is graduated so as to read the current directly in amperes or fraction of an ampere.

A coil of low resistance is joined in parallel with the circuit/Galvanometer.

AC and DC Current – The AC is that current in which the magnitude and direction changes periodically.

The magnitude and directions remains same in DC.

DC also known as steady current

RMS and peak values of current- Root mean square is the effective value of the total waveform.

It is equal to the level of the DC signal that would provide the same average period as the periodic signal.

The peak value is the highest voltage that the waveform will ever reach.

UNIT-5: SOUND

Sound is a vibration that propagates as acoustic waves, through a transmission medium such as gas, liquid or solid.

Propagation of sound- It is a sequence of waves of peruses which propagates through compressible media such as air or water.

During propagation waves can be reflected, refracted or attenuated by the medium.

Medium of sound propagation- the matter of substance through which sound is transmitted is called a medium. It can be solid, liquid or gas.

Ultrasonic Waves- Are sound wave transmitted above the human detectable frequency range, usually above 20,000 HZ

Clinical Application of ultrasound-

- > Ultrasonic cleaning
- > Ultrasonic disintegration
- > Weapons
- > Diagnostic sonography
- > Therapeutic ultrasound
- > Communication
- > Analyze the purity and uniformity of liquid and solid.

Radiation physics

Unit-I Transformers

1.1 It is an electrical device which converts high voltage to low voltage vice versa.

1.2 Working principle- It works on the principle of mutual induction of two coils or Faraday's law of electromagnetic induction.

1.3 Types- It is of three types- 1. Open core 2. closed core 3. Auto transformer

Open core- It is constructed like induction coil. Primary coil is wound around core of laminated iron and the Secondary coil wound about the Primary.

Closed core- In this Primary and Secondary coils are wound sides at opp. Of an iron core formed as a hollow square.

Auto transformers- Made up of a single coil of wire wound, wound a soft iron core which consist of large no of turns, part of which is used both as Secondary and Primary two circuits being electrically connected.

1.4 Construction of step up and step down transformer-

-Step up in it the Primary winding is made up of thick insulate a copper wire and the Secondary is made up of thin insulated copper wire

- Step down in it the output current is high so the thick insulated copper wire is used for making Secondary winding.

1.5 Construction of high tension transformer-

Consist of Primary winding made up of few hundred turn of thick copper wire and coated with insulating material such as enamel.

Secondary winding consist of thousand of turns of thin copper wire also coated with enamel.

Both coils are highly insulated from each other.

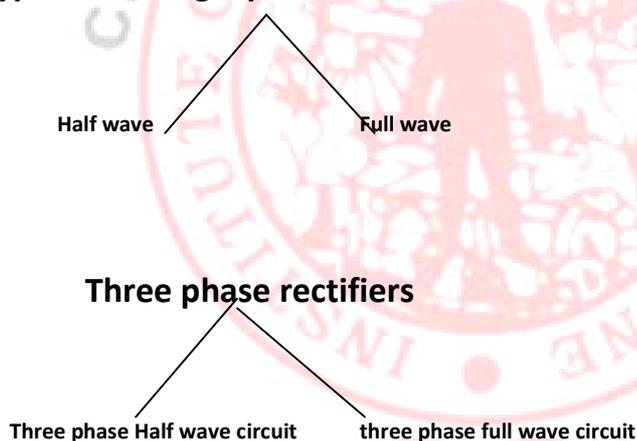
These coils are wound on same core which is shell type metal core.

Core is made up of stalloy which is an alloy of steel and silicon and terminated in slice form on another to reduce eddy current of transformer.

- Primary winding is wound on a cylinder of insulating material in which the core is later inserted.
- Secondary winding is also wound on a cylinder of insulator and filled over the Primary winding

1.6 Rectification- The process by which an electrical device converts AC in Dc and Vice-versa is called rectification and the device is called a Rectifier. Diode in the diagnostic X-Ray tube is a rectifier.

Types- 1- Single phase rectifiers



Advantages- The circuit of half wave rectifiers is very simple and of low cost

Disadvantages-The pulsating current in output contains AC components whose frequency is equal to supply frequency so filtering is needed

The AC supply delivers power during half cycle only so output is low.

1.7 Half wave and full wave rectification-

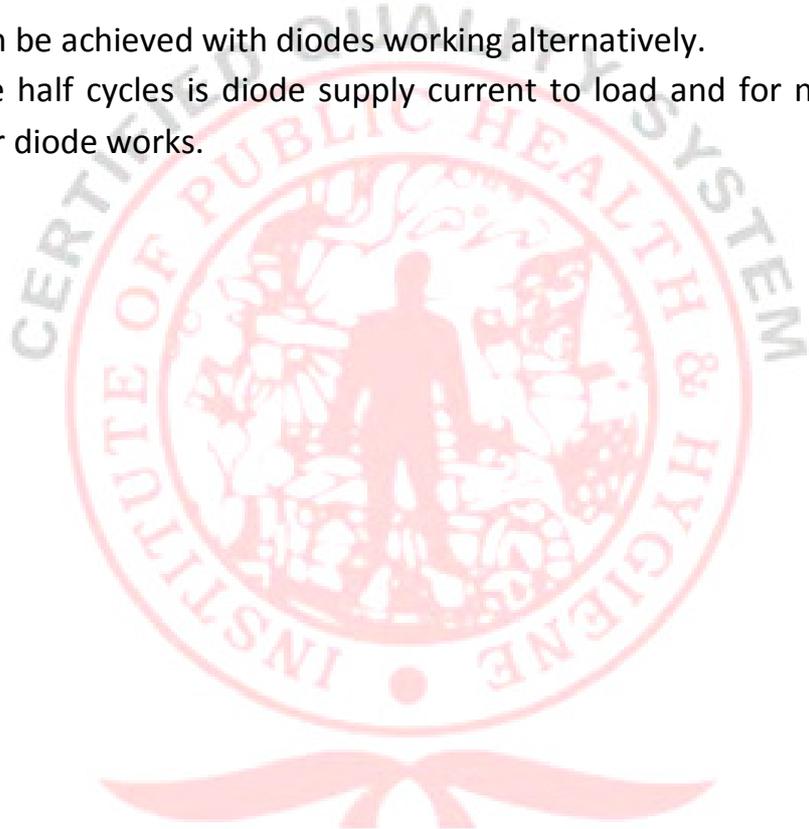
HALF WAVE RECTIFICATION- The process of removing one half of the input signal to establish a DC level is known as half wave rectification.

- It Conducts current during the half cycle of input AC signal only.

- Negative half cycle is suppressed.

FULL WAVE RECTIFICATION- It uses both the cycles of the current. In the first half of the cycle, current flows in negative direction and in the second half, it flows in positive direction. The current flow through the load in same direction for both half and of input AC .

- This can be achieved with diodes working alternatively.
- For one half cycles is diode supply current to load and for next half cycle another diode works.



विद्यैव बलम्

Unit-2 X-RAYS

Definition- They are electromagnetic radiation that differentially penetrates structure within the body and creates images of these structure on photographic film or a fluorescent screen. These images are called X-Rays.

Properties of X-Rays-

1. They possess high penetrating power
2. They are electrically neutral
3. They travel in a straight line
4. They can not focus by the lens
5. They liberate minute amount of heat when passing through matter
6. Their wave length ranges from 0.1-0.5 Å⁰

Production of X-Rays- X-Rays is produced by energy conversion when fast moving electrons from element of X-Ray tube interact with the tungsten anode

2.1 Interaction of X-Rays with matter-There are four types of radiation which forms after X-Rays interact with matter-Scholastic effect & Non-scholastic effect, coherent scattering, photoelectric absorption and Compton Effect or Pair Production. There is another kind of effect with specific radiation characteristics called photon disintegration.

2.1.1 Bremsstrahlung's Radiation- When an energetic particle having the energy value (e^-) completely avoids the orbital energy and come sufficiently close to nucleus of atom its kinetic energy is splitted into positive and negatively charged particles under the influence of the nuclear energy

- Because e^- is negatively charged and nucleus is positively charged, an electrostatic force of attraction arises between them.
- This force is very strong because nucleus contain many proton and distance between nucleus and high speed electrons is very small
- So when an energy e^- passes by the nucleus it is de-accelerated resulting in loss of Kinetic energy

- This loss of Kinetic energy is converted into X-Rays known as bremsstrahlung's radiation.

2.1.2 Characteristic radiation –

- When the energy of e^- interacts on target exceeded the binding energy of inner shell e^- of nucleus, discrete energy spikes are superimposed on bremsstrahlung radiation .
- An electron – electron interaction can result in ejection of inner shell e^- from its orbit .leaving an ionized atom with unfilled inner shell.
- When this happens an e^- from outershell will fill the vacancy and with these transition characteristic X-Rays are produced.

2.1.3 Compton effect-

- In 1929 A.H Compton was first to predict this type of interaction.
- An incident photon having moderate energy strikes with an outer shell e^- of an atom and eject an e^- from its orbit.
- This photon is deflected by an e^- so that it travels in a new direction as scattered photon.
- Thus, Compton reaction produced an ion pair a positive atom and a negative e^- known as recoil electron.

2.1.4 Pair Production-

- If an incident X-Rays has sufficient energy it may escape interaction with the e^- shells and come close enough to the nucleus of the atom to be influenced by strong electrostatic field of nucleus.
- In its place appear two e^- one positive charged called positron and negative charge electron.
- The energy equivalence of the mass of an e^- is calculated to equal 0.51 MeV.
- Since, two electron are formed in a pair product ion interaction the incident photon must have at least 1.02 MeV of energy
- It rarely occurs in the diagnostic X-Rays.



विद्यैव बलम्



विद्यैव बलम्