| | |
|---|---|
| Program : **Diploma in Engineering and Technology** | |
| Course Code : **1003** | Course Title: **Applied Physics-I** |
| Semester : **1** | Credits: **3** |
| Course Category: **Basic Science** | |
| Periods per week: **3 (L:3 T:0 P:0)** | Periods per semester: **45** |

Dr. Jinchu.I

# Course Objectives:

- To provide students with a broad understanding of physical principles of the universe to help them develop critical thinking and quantitative reasoning skills.
- To help the diploma engineers in applying the basic concepts of physics to solve broad-based engineering problems

# Module 1:

- Physical quantities - Fundamental and derived, Units and systems of units (CGS, MKS and SI units),
- Measurements - Errors in measurements- systematic and random errors (qualitative idea only), absolute error, relative error, percentage error, numerical problems
- Scalar and Vector quantities - Representation of vector, Collinear vectors, Coplanar vectors, equal vectors, unit vectors. Addition and Subtraction of Vectors, Triangle and Parallelogram law of addition, Resolution of a Vector.
- Equations of motion (elementary idea), Newton's laws of motion (no derivation), Force, Momentum, Statement and derivation of conservation of linear momentum, its applications - recoil of gun and rocket propulsion, Impulse and its examples (numerical problems related to force and momentum).

# Questions?

- What is Physics?
  - Physics deals with the study of the basic laws of nature and their manifestation in different phenomena
- Scope?
  - Wide covering a tremendous range of magnitude of physical quantities
- Relation between Physics, technology and society
  - Technology gives rise to new physics: Physics generates new technology:- direct impact on society

# Fundamental forces in nature

- Gravitational Force: force of attraction between objects (weakest force)
- Electromagnetic Force: force of attraction between charged particles
- Strong Nuclear Force: strongest force binds protons and neutrons
- Weak nuclear force: responsible for particle decay

# Physical Quantities

- Any quantity which can be measured directly or indirectly in terms of which any laws of physics can be expressed is called physical quantity.
  - The property of an object that can be quantified.
    - Examples :
    - the length of a rod
    - the mass of a body.
    - The time taken to travel a distance
    - The current flowing through a conductor
    - The speed of a vehicle

- UNITS: Measurement of any physical quantity involves its comparison with a certain basic, reference standard called unit.
- Measurement: is the act of comparing a physical quantity with its unit.
- Measurement result is the value of a physical quantity obtained by means of measurement.

# How are physical quantities classified?

- Scientists know many physical quantities, which are classified into **basic and derived.**
- The basic quantities are length, time, mass, electric current, temperature, luminous intensity and the amount of substance.
- Fundamental or base quantities are quantities which cannot

be expressed in terms of any other physical quantities.

The measurements of physical quantities are expressed in terms of units, which are standardized values.

The distance of a race, which is a physical quantity, can be expressed in meters (for sprinters) or kilometers (for long distance runners).

Without standardized units, it would be extremely difficult for scientists to express and compare measured values in a meaningful way

# Derived quantities

- They can be expressed in terms of fundamental quantities. The units of derived quantities are expressed in terms of fundamental units and they are called derived quantities.

Eg: Velocity, Force etc

# International system of units (SI)

- This system of units was introduced in 1971 by the general conference on weights and measures and was internationally accepted.
- It has seven fundamental units along with two supplementary units.
- All physical quantities in the International System of Units (SI) are expressed in terms of combinations of seven fundamental physical units, which are units for: length, mass, time, electric current, temperature, amount of a substance, and luminous intensity

# SI Base Units

| Quantity | Unit | Symbol |
|---|---|---|
| Length | meter | m |
| Mass | kilogram | kg |
| Time | second | s |
| Temperature | kelvin | K |
| Amount of substance | mole | mol |
| Electric current | ampere | A |
| Luminous intensity | candela | cd |
| Plane angle | radian | rad |
| Solid angle | steradian | sr |

# Advantages of SI System of Units

- It is a coherent system of units.

  i.e., a system based on certain set of fundamental units.

- It is a rational system of units.

  i.e., it assigns only one unit to a particular physical quantity.

- SI is a metric system.

  i.e., multiples and submultiples of the system can be expressed as power of 10

# System of Units

## SYSTEM OF UNITS

| | SI | MKS | CGS | BRITISH |
|---|---|---|---|---|
| LENGTH | METER | METER | CENTIMETER | FOOT |
| MASS | KILOGRAM | KILOGRAM | GRAM | POUND |
| TIME | SECOND | SECOND | SECOND | SECOND |

# Length – meter (m)

- The SI unit for length is the meter (m).
- The definition of the meter has changed over time to become more accurate and precise.
- It was first defined in 1791 as 1/10,000,000 of the distance from the equator to the North Pole.
- In 1889 it is redefined as the meter to be the distance between two engraved lines on a platinum-iridium bar. (The bar is now housed at the International Bureau of Weights and Measures, near Paris).

# Length –meter (m)

- By 1960, some distances could be measured more precisely by comparing them to wavelengths of light. The meter was redefined as 1,650,763.73 wavelengths of orange light emitted by krypton atoms.
- In 1983, the meter was given its present definition as the distance

light travels in a vacuum in 1/ 299,792,458 of a second.

# Mass- kilogram (kg)

- The SI unit for mass is the kilogram (kg).
- It is defined to be the mass of a platinum-iridium cylinder, housed at the International Bureau of Weights and Measures near Paris.
- Exact replicas of the standard kilogram cylinder are kept in numerous locations throughout the world, such as the National Institute of Standards and Technology in Gaithersburg, Maryland.
- The determination of all other masses can be done by comparing them with one of these standard kilograms.

# Time : second (s)

- The SI unit for time, second (s).
- For many years it was defined as 1/86,400 of an average solar day. However, the average solar day is actually very gradually getting longer due to gradual slowing of Earth's rotation.
- Accuracy in the fundamental units is essential, since all other measurements are derived from them. Therefore, a new standard was adopted to define the second in terms of a non-varying, or constant, physical phenomenon.
- One constant phenomenon is the very steady vibration of Cesium atoms, which can be observed and counted. This vibration forms the basis of the cesium atomic clock.
- In 1967, the second was redefined as the time required for 9,192,631,770 Cesium atom vibrations




- An atomic clock such as this one uses the vibrations of cesium atoms to keep time to a precision of one microsecond per year. The fundamental unit of time, the second, is based on such clocks. This image is looking down from the top of an atomic clock

# Electric Current- ampere (A)

- Electric current is measured in the ampere (A), named after Andre Ampere.

- Understanding an ampere requires a basic understanding of electricity and magnetism.

- Basically, two parallel wires with an electric current running through them will produce an attractive force on each other.

- One ampere is defined as the amount of electric current that will produce an attractive force of 2.7 × 10–7 newton per meter of separation between the two wires (the newton is the derived unit of force).

# Temperature- kelvin (K)

- The SI unit of temperature is the kelvin (or kelvins, but not degrees kelvin).
- This scale is named after physicist William Thomson, Lord Kelvin, who was the first to call for an absolute temperature scale.
- The Kelvin scale is based on absolute zero. This is the point at which all thermal energy has been removed from all atoms or molecules in a system.
- This temperature, 0 K, is equal to −273.15 °C and −459.67 °F. Conveniently, the Kelvin scale actually changes in the same way as the Celsius scale.
- For example, the freezing point (0 °C) and boiling points of water (100°C) are 100 degrees apart on the Celsius scale. These two temperatures are also 100 kelvins apart (freezing point = 273.15 K; boiling point = 373.15 K).

# Luminous intensity -candela(cd)

- The candela is the SI's base unit for photometry.
- Defined as the luminous intensity in a given direction of a source that emits monochromatic radiation of frequency 540 × 10^12 hertz and has a radiant intensity in that same direction of 1/683 watt per steradian (unit solid angle).
- The candela is used to measure the visual intensity of light sources, like light bulbs or the bulbs in torches. It is the only SI base unit based on human perception.
- The candela converts the power of optical radiation to perceived luminance, originally defined as one candlepower (with the candle made of sperm whale wax)

- The ‘new candle’, or ‘candela’, was introduced in 1948 and later modified in 1979.
- The human eye has different sensitivities to different frequencies of light.
- The peak sensitivity is at approximately 540THz, which is in the greeny-yellow region of the spectrum. So we see this light more intensely than other colours of the same physical power.
- The ‘lumen’ is derived from the candela and measures total light in all directions from a source.

# Amount of Substance- mole(mol)

- One mole (mol) contains exactly $6.02214076 \times 10^{23}$ elementary entities. This number is the fixed numerical value of the Avogadro constant, $N_A$, when expressed in the unit $mol^{-1}$ and is called the Avogadro number.
- The amount of substance, symbol n, of a system is a measure of the number of specified elementary entities. ▫ An elementary entity may be an atom, a molecule, an ion, an electron, any other particle or specified group of particles.

- When the mole is used, the elementary entities must be specified and may be atoms, molecules, ions, electrons, other particles, or specified groups of such particles. The SI unit of concentration (of amount of substance) is the mole per cubic meter (mol/m3).
- The SI unit of concentration (of amount of substance) is the mole per cubic meter (mol/m3)
- One mole (mol) contains exactly $6.02214076 \times 10^{23}$ elementary entities. This number is the fixed numerical value of the Avogadro constant, NA, when expressed in the unit mol−1 and is called the Avogadro number.
- The amount of substance, symbol n, of a system is a measure of the number of specified elementary entities. An elementary entity may be an atom, a molecule, an ion, an electron, any other particle or specified group of particles.

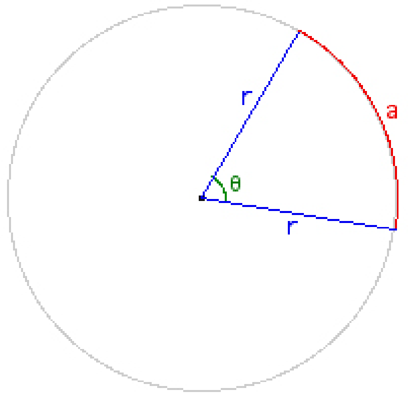
# Plane angle -radian(rad)

- SI unit of plane angle is radian
- Radian describes the plane angle subtended by a circular arc, as the length of the arc divided by the radius of the arc.
- One radian is the angle subtended at the center of a circle by an arc that is equal in length to the radius of the circle.

One radian is $\frac{180°}{\pi}$ [approximately 57.3°].

One degree is $\frac{\pi}{180}$ rad [approximately 0.0175 rad].

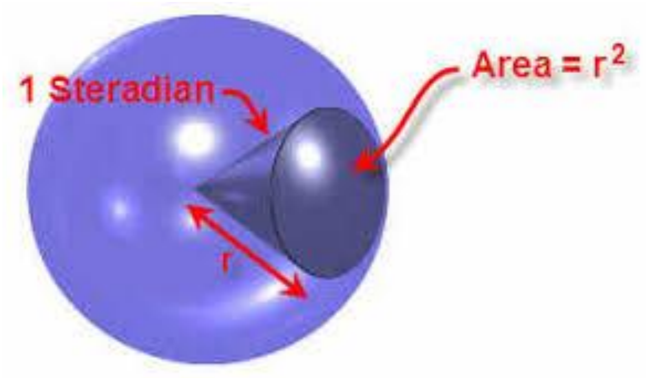
In the illustration below, $\theta$ is an angle described in radian measure.




$$\theta = \frac{a}{r}$$

# Solid angle- steradian(sr)

- Steradian, unit of solid-angle
- measure in the International System of Units (SI), defined as the solid angle of a sphere subtended by a portion of the surface whose area is equal to the square of the sphere's radius.
- A steradian is (180/π)2 square degrees or about 3282.8 square degrees.



- Steradian, unit of solid-angle measure in the International System of Units(SI),
-  Since the complete surface area of a sphere is 4π times the square of its radius, the total solid angle about a point is equal to 4π steradians.
- Derived from the Greek for solid and the English word radian, a steradian is, in effect, a solid radian;
- The radian is an SI unit of plane-angle measurement defined as the angle of a circle subtended by an arc equal in length to the circle’s radius.