LAPLACE'S EQUATION →

The Laplace's differential equation is

$$\nabla^2 \phi = 0$$

This is most important and most commonly used differential equation and occurs in studying the

(i) Gravitational potential in regions containing no matter,

(ii) The electrostatic potential in a uniform dielectric, in the theory of electrostatics.

(iii) The magnetic potential in free space, in the theory of magnetostatics

(iv) The electric potential in the theory of the steady flow of electric currents in solid conductors.

(v) The temperature in the theory of thermal equilibrium of solids.

(vi) The velocity potential at points of a homogeneous liquid moveing irrotationally in hydrodynamical problems.

2. Poisson Equation →

The poisson's differential equation is

$$\nabla^2 \phi = \rho$$

where ρ is a function of position co-ordinates and is called the source density. The function ϕ may represent the same physical quantities as for Laplace's equation. But in a region containing matter or electric charge or magnetic source or heat source or fluid source depending on physical situation.

3. Heat flow equation →

The time dependent heat flow equation is

$$\nabla^2 \phi = \frac{1}{h^2} \frac{\partial \phi}{\partial t}$$

where h^2 is a constant and is called the diffusivity whereas ϕ may be the non-steady state temperature with no heat source or it may be the concentration of a diffusing material.