

LECTURE NO 15

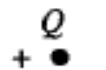
Electrostatics

Topics

- Electric field due to charge distribution,
- Point charge
- Surface charge
- Volume Charge
- Electric flux density

Continuous Charge Distribution

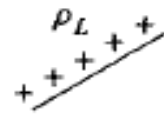
$$dQ = \rho_L dl \rightarrow Q = \int_L \rho_L dl$$



A single positive charge represented by a plus sign and a solid black dot.

Q
+ ●

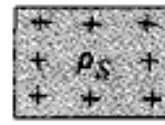
Point
charge



A line of positive charges represented by a diagonal line with several plus signs above it. The symbol ρ_L is written above the line.

ρ_L
+ + + +

Line
charge



A rectangular surface with a grid of plus signs inside. The symbol ρ_S is written in the center.

+ + +
+ ρ_S +
+ + +

Surface
charge



An irregularly shaped volume filled with plus signs. The symbol ρ_V is written in the center.

+ + +
+ + +
+ ρ_V +
+ + +

Volume
charge

$$dQ = \rho_S dS \rightarrow Q = \int_S \rho_S dS \quad (\text{surface charge})$$

$$dQ = \rho_V dv \rightarrow Q = \int_V \rho_V dv \quad (\text{volume charge})$$

$$\mathbf{E} = \int \frac{\rho_L dl}{4\pi\epsilon_0 R^2} \mathbf{a}_R \quad (\text{line charge})$$

$$\mathbf{E} = \int \frac{\rho_S dS}{4\pi\epsilon_0 R^2} \mathbf{a}_R \quad (\text{surface charge})$$

$$\mathbf{E} = \int \frac{\rho_V dv}{4\pi\epsilon_0 R^2} \mathbf{a}_R \quad (\text{volume charge})$$

ELECTRIC FLUX DENSITY

$$\mathbf{D} = \epsilon_0 \mathbf{E}$$

We define *electric flux* Ψ in terms of \mathbf{D} using eq. (3.13), namely,

$$\Psi = \int \mathbf{D} \cdot d\mathbf{S} \quad (4.36)$$

In SI units, one line of electric flux emanates from $+1$ C and terminates on -1 C. Therefore, the electric flux is measured in coulombs. Hence, the vector field \mathbf{D} is called the *electric flux density* and is measured in coulombs per square meter. For historical reasons, the electric flux density is also called *electric displacement*.