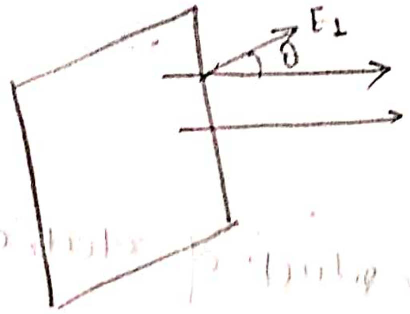
Electric Flux

The electric flux ϕ_E through the surface is defined as the product of the area A and the normal component of the electric field.

Let $E_\perp$ be the perpendicular component of electric field

Electric flux $\phi_E = E_\perp A$

S.I unit $N/c \cdot m^2$ or $N m^2/c$



As we can see from above figure, angle between surface area and ~~normal component of~~ Electric field is θ.

so, the normal component of electric field will be $E_\perp = E\cos\theta$

$\therefore \phi_E = EA\cos\theta$.

The product $A\cos\theta$ can be interpreted as the projection of the area A onto a plane perpendicular to the electric field; that is, $A\cos\theta$ can be regarded as that portion of the area that effectively faces the electric field.

so, flux can also be defined as product of magnitude of electric field facing area perpendicular to the field.

case I

when $\theta = 0°$

$$\phi_E = EA$$

Here area A is exactly face on to the electric field and it intercepts the maximum number of field lines.

case II

when $\theta = 90°$

$$\phi_E = 0$$

Here area A is exactly parallel to the electric field and all the field lines skim by the area without crossing it.

Vector Notation

$$\phi_E = EA\cos\theta$$
$$= \vec{E} \cdot \vec{A}$$

Mathematically flux is dot product of electric field vector $\vec{E}$ and vector area $\vec{A}$.

$$\vec{A} = A\hat{n}$$

Here A is magnitude equal to the ordinary surface area.
$\hat{n}$ is unit vector perpendicular to the surface or normal to the surface.

If the surface of interest consists of several flat areas, each intercepting a uniform field $\vec{E}$ then

total flux $\phi_E = \sum_i E_\perp A_i = \sum_i \vec{E} \cdot \vec{A_i}$

↓

sum of the fluxes through each area.