Understanding Electric Flux

What is Electric Flux?

- Electric flux is a measure of the electric field passing through a surface.
- It is calculated as the product of the electric field and the area of the surface.
- The formula is: $\Phi = E \times A \times \cos(\varphi)$

Understanding the Components

- E represents the electric field strength.
- A is the area of the surface.
- φ is the angle between the electric field and the normal to the surface.

Electric Field Perpendicular to Surface

- When the electric field is perpendicular to the surface, $\varphi = 0°$.
- In this case, $\cos(0°) = 1$, so $\Phi = E \times A$.
- This results in maximum electric flux.

Electric Field at an Angle

- If the electric field is at an angle to the surface, φ is not zero.
- The electric flux is then calculated as $\Phi = E \times A \times \cos(\varphi)$.
- The angle φ affects the amount of flux passing through the surface.

Electric Field Parallel to Surface

- When the electric field is parallel to the surface, $\varphi = 90°$.
- In this case, $\cos(90°) = 0$, resulting in zero electric flux.
- No electric field lines pass through the surface.

Example Problem: Sphere with Charges

- Consider a sphere of radius 4 meters with a 50 μC charge at its center.
- The electric flux through the sphere can be calculated using Gauss's Law.
- The formula is: $\Phi = Q_{enc} / \varepsilon_0$, where Q_enc is the enclosed charge.

Calculating Electric Flux for the Sphere

- For the sphere with a positive and negative charge, the total enclosed charge is zero.
- Thus, the electric flux through the sphere is also zero.
- This illustrates the concept of electric flux in closed surfaces.

Gauss's Law Overview

- Gauss's Law states that the electric flux through a closed surface is proportional to the charge enclosed.
- Mathematically: $\Phi = Q_{enc} / \varepsilon_0$.
- This law simplifies the calculation of electric flux in complex situations.

Example Problem: Horizontal Disk

- Consider a horizontal disk with an electric field at an angle of 30°.
- The electric flux can be calculated using the formula: $\Phi = E \times A \times \cos(\varphi)$.
- Here, φ is the complementary angle to the angle of the electric field.

Calculating Electric Flux for the Disk

- The area of the disk is $A = \pi r^2$, where r is the radius.
- Substitute values to find the electric flux.
- This example demonstrates the application of electric flux in real scenarios.

Electric Flux through a Cube

- When a positive charge is placed at the center of a cube, the total electric flux can be calculated.
- Use Gauss's Law: $\Phi = Q_{enc} / \varepsilon_0$.
- This approach simplifies the calculation without needing to analyze each face of the cube.

Electric Flux through Cube Faces

- To find the flux through one face of the cube, divide the total flux by 6.
- Each face experiences the same amount of flux due to symmetry.
- This is a practical application of Gauss's Law.

Electric Flux with No Charge

- If there is no charge inside a closed surface, the total electric flux is zero.
- This is consistent with Gauss's Law: $\Phi = Q_{enc} / \varepsilon_0$, where $Q_{enc} = 0$.
- The flux entering equals the flux leaving the surface.

Summary of Key Concepts

- Electric flux is a measure of the electric field through a surface.
- It depends on the electric field strength, area, and angle.
- Gauss's Law provides a powerful tool for calculating electric flux.

Conclusion

- Understanding electric flux is crucial in electromagnetism.
- It helps in analyzing electric fields and their effects on surfaces.
- Thank you for your attention! Any questions?