Module IV

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Contents

1 Maxwell's equations and EM waves

1.1 Topics to be covered.

1.1.1 Maxwell's equations

Fundamentals of vector calculus, Divergence and Curl of **E** *and* **B** *(static), Gauss' divergence theorem and* **Stokes'theorem**. *Description of laws of electrostatics, Faraday's laws of* **EMI**. *Current density* **J** *and Equation of Continuity. Displacement current with derivation and Maxwell's equations in* **vacuum**

1.1.2 EM Waves

The wave equation in differential form in free space (derivation using Maxwell's equations), Plane EM waves(in vacuum), Transverse Nature and Polarization of EM waves

2 Fundamentals of vector calculus

A *scalar* is a physical quantity with only magnitude.
A *vector* is a physical quantity with both magnitude and direction.
A *unit vector* like $\hat{a}$ has a magnitude of 1
In *Cartesian coordinates*, $\vec{a} = a_1e_1 + a_2e_2 + a_3e_3$ where e_1, e_2 and e_3 are unit vectors.
Magnitude $|a| = \sqrt{a_1^2 + a_2^2 + a_3^2}$

2.1 Dot product (scalar product)

$a \cdot b = |a| \cdot |b| \cdot cos(\theta) = a_1b_1 + a_2b_2 + a_3c_3$ is a scalar

2.2 Cross product (vector product)

$$a \times b = |a||b|sin(\theta)\hat{n}$$

In terms of components a and b

$$a \times b = \begin{vmatrix} e_1 & e_2 & e_3 \\ a_1 & a_2 & a_3 \\ b_1 & b_2 & b_3 \end{vmatrix}$$

or

$$a \times b = ()$$