Electromagnetic waves

Lecture 8

Maxwell Equations

Bashaer Albdulhamza
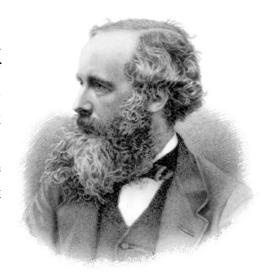
Araa Hassa

Tow stage
Department of medical physics
Al-Mustaqbal University-College

Maxwell's equations

James Clerk Maxwell FRSE FRS (13 June 1831 – 5 November 1879) was a Scottish mathematician and scientist responsible for the classical theory of electromagnetic radiation, which was the first theory to describe electricity, magnetism and light as different manifestations of the same phenomenon. Maxwell's equations for electromagnetism have been called the "second great unification in physics" . where the first one had been realised by Isaac Newton.

With the publication of "A Dynamical Theory of the Electromagnetic Field" in 1865, Maxwell demonstrated that electric and magnetic fields travel through space as waves moving at the speed of light. He proposed that light is an undulation in the same medium that is the cause of electric and magnetic phenomena. The unification of light and electrical phenomena led to his prediction of the existence of radio waves. Maxwell is also regarded as a founder of the modern field of electrical engineering.

Maxwell's Equations

Differential Form		Integral Form	
$\vec{\nabla} \cdot \vec{D} = \rho$	$\iiint_V (\nabla \cdot \vec{F})\, dV = \oiint_S \vec{F} \cdot d\vec{S}$ Gauss' theorem	$\oiint_S \vec{D} \cdot d\vec{S} = \iiint_V \rho\, dV$	Gauss's law
$\vec{\nabla} \cdot \vec{B} = 0$		$\oiint_S \vec{B} \cdot d\vec{S} = 0$	Gauss's law for magnetism
$\vec{\nabla} \times \vec{E} = -\dfrac{\partial \vec{B}}{\partial t}$	$\iint_S (\nabla \times \vec{F}) \cdot d\vec{S} = \oint_{ds} \vec{F} \cdot d\vec{l}$ Stokes' theorem	$\oint_{\partial S} \vec{E} \cdot d\vec{l} = -\iint_S \dfrac{\partial \vec{B}}{\partial t} \cdot d\vec{S}$	Faraday's law of induction
$\vec{\nabla} \times \vec{H} = \vec{J} + \dfrac{\partial \vec{D}}{\partial t}$		$\oint_{\partial S} \vec{H} \cdot d\vec{l} = \iint_S \vec{J} \cdot d\vec{S} + \iint_S \dfrac{\partial \vec{D}}{\partial t} \cdot d\vec{S}$	Ampère's law