In this section of *Resonance*, we invite readers to pose questions likely to be raised in a classroom situation. We may suggest strategies for dealing with them, or invite responses, or both. “Classroom” is equally a forum for raising broader issues and sharing personal experiences and viewpoints on matters related to teaching and learning science.

**A Direct Experimental Proof of Displacement Current**

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An experimental effort has been made to validate the existence of displacement current which produces magnetic field like any other form of current. The generation of emf by a loop placed parallel to the current and its square-law variation with frequency has been experimentally demonstrated. All experimental results also confirm the theory developed.

1. Introduction

The development of electromagnetic theory by James Clerk Maxwell in 1865 [1] was truly a fundamental stepping stone which laid the solid foundation for a clear understanding of all electromagnetic phenomena like interference, diffraction, polarization, guided waves, propagation and radiation of energy, and velocity of light. It also contained the full information of all previous existing laws of electricity and magnetism by Coulomb, Gauss, Ampere and several others [2].

**Keywords**
Electromagnetic theory, Maxwell’s equations, displacement current.
Without this displacement current, many electromagnetic phenomena like radiation and propagation of energy, guided waves, and antennas, cannot be explained at all.

The Maxwell’s equations in differential form are

\[ \nabla \times \mathbf{H} = \sigma \mathbf{E} + \frac{\partial \mathbf{D}}{\partial t} \]  

(1a)

\[ \nabla \times \mathbf{E} = -\frac{\partial \mathbf{B}}{\partial t} \]  

(1b)

\[ \nabla \cdot \mathbf{D} = \rho \]  

(1c)

\[ \nabla \cdot \mathbf{B} = 0 \]  

(1d)

where the symbols have their usual significance. The key and original concept of Maxwell was the introduction of the term of displacement current density, \( \partial \mathbf{D} / \partial t \) (in equation (1a) above) which flows in a dielectric medium and acts, for all intents and purposes, exactly like the conduction current density, \( \sigma \mathbf{E} \) flowing in a conducting medium [3]. Without this displacement current, many electromagnetic phenomena like radiation and propagation of energy, guided waves, and antennas, cannot be explained at all ([4]–[8]).

The objective of the present article is to describe a simple experiment which will directly and convincingly show that the displacement current is as real as the conduction current.

2. Theory

The basic principle is easily understood by considering a parallel plate air dielectric capacitor as shown in Figures 1a and 1b. When an ac voltage \( V_1 e^{j\omega t} \) is applied across the plates, there will be no conduction current in the air dielectric between the plates; however, since the electric field, \( \mathbf{E} = (\mathbf{u}_z V_1 / d) e^{j\omega t} \) and the displacement current vector, \( \mathbf{D} = \mathbf{u}_z (\varepsilon_0 V_1 / d) e^{j\omega t} \) vary sinusoidally with time, a displacement current of density,

\[ \mathbf{J}_d = \frac{\partial \mathbf{D}}{\partial t} = \mathbf{u}_z \left( \frac{j 2\pi f \varepsilon_0 V_1}{d} \right) e^{j\omega t} \]

is produced in the air dielectric. This, in turn, will produce a circular magnetic field, \( H_\phi \) around the axis. If