DEPARTMENT OF PHYSICS AND NANOTECHNOLOGY
SRM INSTITUTE OF SCIENCE AND TECHNOLOGY

18PYB101J-Electromagnetic Theory, Quantum Mechanics, Waves and Optics

Module I Lecture-10

Solving Problems

1. Determine the current density when 40 Amperes of current is flowing through the battery in a given area of 10 m^2.

Solution:

It is given that,

I = 40 A,

Area = 10 m^2

The current density formula is given by,

J = I / A

J = 40 / 10

J = 4 A/m^2.

2. A 5 mm^2 copper wire has a current of 5 mA of current flowing through it. Determine the current density.

Solution

Given:

Total Current I is 5 mA

Total Area A is 5 mm^2

The Current density J = I / A

$J = 5\times10^{-3} / 5\times10^{-3}$

$J = 1\ A/m^2$

3. The magnetic flux through the loop is $\Phi_B = 6t^2 + 7t$, where Φ_B is in milliwebers and t is in seconds. What is the magnitude of the emf induced in the loop when t = 2.0 s?

Solution

Given:

$\Phi_B = 6t^2 + 7t$

$t = 2.0$ s

Induced emf $e = -d\Phi/dt$

$e = d/dt(6t^2 + 7t)$

$e = -(12t+7)$ mWb/s

At t = 2s

$e = -\{(12\times2)+7\}$ mWb/s

$e = -31\times 10^{-3}$ (Wb/s) mV

4. Show the equation of continuity div J+dρ/dt = 0 is contained in Maxwell's equation.
According to Maxwell's fourth equation,

Curl H = J+dD/dt

Taking divergence on both sides

div (curl H)=div (J+dD/dt)

div (curl H)=0

div (J+dD/dt) = 0 or

divJ+ d/dt(divD)=0

From Maxwell's first equation

divD = ρ,

Where ρ is the surface charge density.

divJ +dρ/dt = 0