Prerequisite 1: Assignment

Fundamentals of Electromagnetism

& Signal Processing

Submitted by:

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Problem Statement:

As a researcher conducting experiments in a laboratory focused on electromagnetism and torque phenomena, you're tasked with analyzing the behavior of magnetic dipoles and the effects of external forces on them. Your research aims to understand and quantify various parameters related to magnetic dipoles and torque within experimental setups.

Tasks to be Performed:

1. Moment of Force (torque)

Given:
Force (F) = 10 N
Perpendicular distance (d) from the line of action of the force to pivot = 0.5 meters

Solution:
Formula:
$\tau = F \times d$
$= 10*0.5$
$= 5$ Nm

Therefore, the moment of force is **5 Nm.**

2. Square Waveforms

Given:
Frequency (f) = 50 Hz
Duty cycle (D) = 75%

For a square waveform signal used in the experiment, find the period and duration of the high state (logic level 1) of the square wave.

Solution:
Period of Square Waveform:
Formula:
$T = 1/f$
$= 1/50$
$= 0.02$ sec

Duration of High State (T high):
Formula:
T high = D*T
= 0.75*0.02
= 0.015 sec

3. Magnetic Dipole Moment (m) of a tiny magnet:

Given:
Number of turns in the coil (N) = 100
Current flowing through the coil (I) = 0.5 A
Area of the coil (A) = 0.02 m^2

Solution:
Formula:
m = NIA
= 100*0.5*0.02
= 1 Am^2

Therefore, the value of the magnetic dipole moment (m) of a tiny magnet is **1** Ampere meter squared.

4. Magnetic Dipole Moment

Given:
Pole strength (m) = 2 A-m
Distance between the north and south poles (d) = 0.01 m

Solution:
Formula:
$\mu = m * d$
= 2*0.01
= 0.02 Am^2

Therefore, the value of the magnetic dipole moment (m) is **0.02** Ampere meter squared.

5. Magnetic Moment

Given:
Magnetic moment (m) = 3 A-m^2
External magnetic field (B) = 0.5 T

Solution:
Formula:
$\tau = m \times B$
= 3*0.5
= 1.5

Therefore, the torque on the magnet is **1.5 Nm.**

6. Magnitude of Torque

Given:
Position vector (r) = 0.2 meters
Force vector (F) = 15 N
Angle between the force the lever arm vector (ɵ) = 30 degrees

Solution:
Formula:
$\tau = r \times F$
$\tau = rF\sin\theta$
$= 0.2*15*\sin(30)$
$= 1.5$ Nm

Therefore, the magnitude of torque is **1.5 Nm.**

7. Magnetic dipole potential energy

Given:
Magnetic dipole moment (μ) = 4 A-m^2
Magnetic field strength (B) = 0.8 T
Angle between the magnetic dipole moment (μ) and the magnetic field (B) (θ) = 45 degrees

Solution:
Formula:
$U = -\mu \cdot B \cdot \cos(\theta)$
$= - 4*0.8*\cos(45)$
$= -2.26$ J

Therefore, the magnetic potential energy of a magnetic dipole is **−2.26 J**