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This program calculates forces and torques exerted by a uniform magnetic field. It finds the force exerted on either a moving charge or a current carrying conductor located in a magnetic field and the torque exerted on a current loop or a magnetic dipole by a magnetic field. It works for rectangular or circular loops in any orientation or for a loop of arbitrary shape lying in the x-y plane. Either numerical or symbolic solutions can be found, although the symbolic solutions are sometimes slow. The magnetic moment of the loop is first displayed and then the torque. All solutions are copied to the home screen so they can be more easily used in further calculations.

Copyto_h() is used in the main program. Place mag_F_τ() and copyto_h() in the same folder, then run mag_F_τ().

Example 1:

A rectangular coil consists of $N=100$ closely wrapped turns and has dimensions $a=0.400$ m and $b=0.300$ m. The coil is hinged along the y-axis, and its plane makes an angle of 30° with the x-axis. What is the magnitude of the torque exerted on the coil by a uniform magnetic field $B=0.800$ T directed along the x-axis when the current is $I=1.20$ A in the direction shown?

Run mag_F_τ()

Select: 2. Torque on loop

Select: 1. Rectangular Loop

Corner 1: $0.3\cos 30^\circ, 0, 0.3\sin 30^\circ$

Corner 2: $0, 0, 0$

Corner 3: $0, 0.4, 0$

of turns N : 100

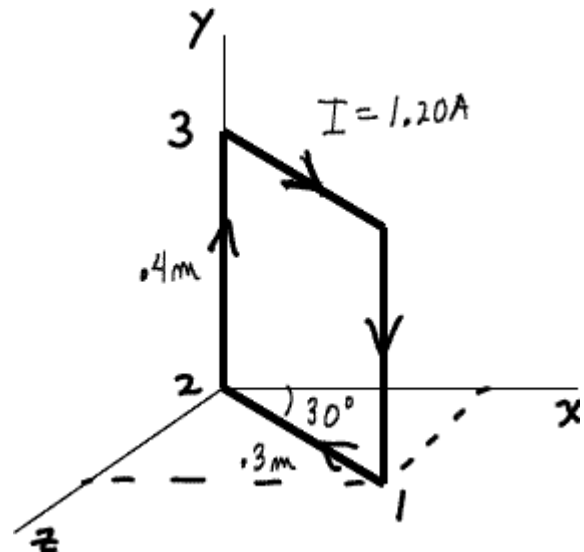
Current I : 1.20

Program displays: $\mu(A \cdot m^2) = [7.2, 0, -12.4708]$
 $|\mu|(A \cdot m^2) = 14.4$

Magnetic Field B : $0.8, 0, 0$

Program displays: $\tau(N \cdot m) = [0, -9.97661, 0]$
 $|\tau|(N \cdot m) = 9.97661$

Results are copied to the home screen.



Example 2:

Repeat Example 1 with a circular coil of radius 2 cm in the same position.

Run mag_F_τ()

Select: 2. Torque on loop

Select: 2. Circular Loop

Point 1: $0.02\cos 30^\circ, 0, 0.02\sin 30^\circ$

Point 2: $0, 0.02, 0$

Point 3: $0.02\cos 30^\circ, 0.04, 0.02\sin 30^\circ$

of turns N: 100

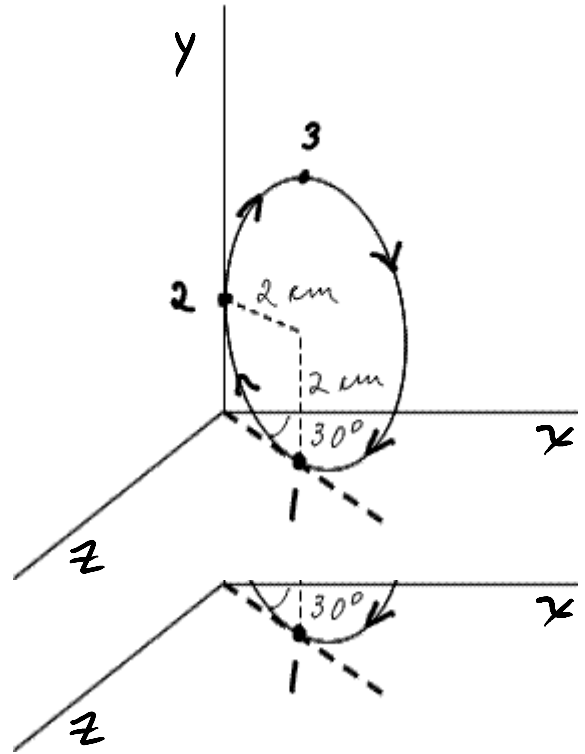
Current I: 1.20

Program displays: $\mu(A \cdot m^2) = [0.075398, 0, -0.130594]$
 $|\mu|(A \cdot m^2) = 0.150796$

Magnetic Field B: 0.8, 0, 0

Program displays: $\tau(N \cdot m) = [0, -0.104475, 0]$
 $|\tau|(N \cdot m) = 0.104475$

Results are copied to the home screen.



Example 3:

200 turn current loop of area 0.20 m^2 in the x-y plane with a counter-clockwise current of 3A in a magnetic field $B = [0.2, 0.3, 0.4]$

Run mag_F_τ()

Select: 2. Torque on loop

Select: 3. Loop in x-y plane

Area: 0.2

of turns: 200

Current: 3

1: Counter-Clockwise

Program displays: $\mu(A \cdot m^2) = [0, 0, 120]$
 $|\mu|(A \cdot m^2) = 120$

Magnetic Field: .2, .3, .4

Program displays: $\tau(N \cdot m) = [-36, 24, 0]$
 $|\tau|(N \cdot m) = 43.2666$

Example 4:

Find the force exerted on the current carrying conductor shown by a magnetic field

$B = [0.2, 0.1, -0.3]$ Tesla .

Run Mag_F_τ

1. Force on conductor

Point 1: 0, 0, 1

Point 2: 3, 4, 2.5

Current I: 3

Magnetic field B: .2, .1, -.3

Program Displays:

$F(N) = [-4.05, 3.6, -1.5]$

