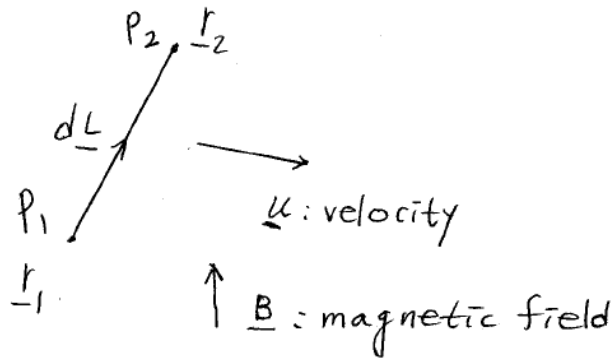


1. Example 1: Electromotive force on a moving linear wire

1) 문제



Given a wire and its velocity in a given magnetic field $\mathbf{B}$, find the electromotive force on the wire.

$$\mathbf{B} = (B_x, B_y, B_z) = (x, y, z)$$

Input:

A linear wire:

x_1, y_1, z_1 : start point(m), P1

x_2, y_2, z_2 : end point(m), P2

u_x, u_y, u_z : velocity vector(m/s)

n : number of segments for numerical integration

Output:

v_{21} : induced electromotive force(V), electric potential difference: $V_2 - V_1$

2) 수식

$$V_{21} = \int_1^2 \mathbf{u} \times \mathbf{B} \cdot d\mathbf{L} = \sum_{k=1}^n \mathbf{u} \times \mathbf{B}(\mathbf{r}_k) \cdot d\mathbf{L} = d\mathbf{L} \cdot \sum_{k=1}^n \mathbf{u} \times \mathbf{B}(\mathbf{r}_k)$$

$$\mathbf{r}_k = \mathbf{r}_1 + (k - 0.5)d\mathbf{L}$$

$$d\mathbf{L} = \frac{\mathbf{r}_2 - \mathbf{r}_1}{n}$$

3) 코드

#EM-14-Python-Ex1: Electromotive force on a moving linear wire

```

#===function: bfield=====
# x,y,z: field point
# bx,by,bz: magnetic flux density(T) at (x,y,z)
def bfield(x,y,z):
    bx=x**3;by=y**3;bz=z**3
    return bx,by,bz
#===end of function: bfield=====
#===function: emf=====
# emf on a linear wire moving in a non-uniform field
# Magnetic field is defined in function bfield
# x1,y1,z1: wire start point(m)
# x2,y2,z2: wire end point(m)
# ux,uy,uz: wire velocity(v/m)
# n: number of wire segments for numerical integration
# v: emf induced on the wire (v2-v1)
def emf(x1,y1,z1,x2,y2,z2,ux,uy,uz,n):
    dx=(x2-x1)/n;dy=(y2-y1)/n;dz=(z2-z1)/n
    fx=0;fy=0;fz=0
    for i in range(1,n+1):
        x=x1+(i-0.5)*dx;y=y1+(i-0.5)*dy;z=z1+(i-0.5)*dz
        bx,by,bz=bfield(x,y,z)
        fx=fx+uy*bz-uz*by;fy=fy+uz*bx-ux*bz;fz=fz+ux*by-uy*bx
    v=dx*fx+dy*fy+dz*fz
    return v
#===end of function: emf=====
#===main program=====
from math import *
while True:
    x1,y1,z1=map(float,input('Wire start point: x1,y1,z1(m)=').split())
    x2,y2,z2=map(float,input('Wire end point: x2,y2,z2(m)=').split())
    ux,uy,uz=map(float,input('Wire velocity: ux,uy,uz(m/s)=').split())
    while True:
        n=int(input('Numer of wire segements for numerical integration: n='))
        if n==0:
            break
        v=emf(x1,y1,z1,x2,y2,z2,ux,uy,uz,n)
        print('Emf on the wire: V(V)=',v)
#===end of main program=====

```

4) 코드 수행결과

```

Wire start point: x1,y1,z1(m)=
1 2 3

```

```
Wire end point: x2,y2,z2(m)=
4 5 6
Wire velocity: ux,uy,uz(m/s)=
-1 3 5
Numer of wire segements for numerical integration: n=
3
Emf on the wire: V(V)= 427.5
Numer of wire segements for numerical integration: n=
5
Emf on the wire: V(V)= 428.460000000000004
Numer of wire segements for numerical integration: n=
10
Emf on the wire: V(V)= 428.865000000000002
Numer of wire segements for numerical integration: n=
20
Emf on the wire: V(V)= 428.966250000000001
Numer of wire segements for numerical integration: n=** Process Stopped **

Press Enter to exit terminal
```