

Problem 1.6.4

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Problem Statement

Show that the vectors $\mathbf{v}_1 = 2\hat{\mathbf{i}} - 3\hat{\mathbf{j}} + 4\hat{\mathbf{k}}$, $\mathbf{v}_2 = -4\hat{\mathbf{i}} + 6\hat{\mathbf{j}} - 8\hat{\mathbf{k}}$ are collinear.

Requirement

To show 2 vectors should be collinear,

$$\text{rank} \begin{pmatrix} \mathbf{v}_1 & \mathbf{v}_2 \end{pmatrix} = 1 \quad (1.1)$$

Converting into Echelon form and Finding Rank

Given vectors \mathbf{v}_1 and \mathbf{v}_2 can be represented as

$$\mathbf{v}_1 = \begin{pmatrix} 2 \\ -3 \\ 4 \end{pmatrix}, \mathbf{v}_2 = \begin{pmatrix} -4 \\ 6 \\ 8 \end{pmatrix} \quad (1.2)$$

We write the vectors as the rows of a matrix:

$$\begin{pmatrix} 2 & -3 & 4 \\ -4 & 6 & -8 \end{pmatrix} \xrightarrow{R_2 \rightarrow R_2 + 2R_1} \begin{pmatrix} 2 & -3 & 4 \\ 0 & 0 & 0 \end{pmatrix} \quad (1.3)$$

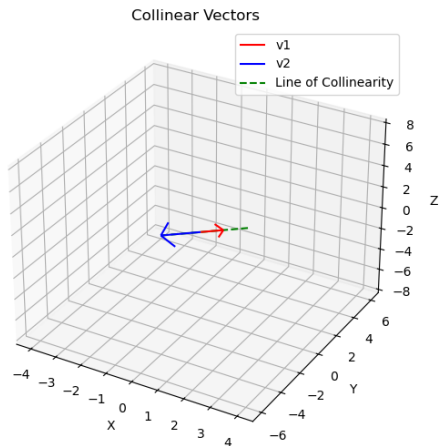
As the last row is entirely zero,
We can say that Rank of the matrix is 1.

Conclusion

Because the rank is 1, the vectors are linearly dependent. Therefore:

$$\mathbf{v}_1 \text{ and } \mathbf{v}_2 \text{ are collinear.} \quad (1.4)$$

Plot



Figure

C Code for generating points on line

```
#include <stdio.h>

static double v1[3] = {2.0, -3.0, 4.0};
static double v2[3] = {-4.0, 6.0, -8.0};

// Function to get v1
double* get_v1() {
    return v1;
}

// Function to get v2
double* get_v2() {
    return v2;
}
```


Python Code for Calling

```
import ctypes

# Load shared library
lib = ctypes.CDLL("./libvectors.so")

# Set return types
lib.get_v1.restype = ctypes.POINTER(ctypes.c_double)
lib.get_v2.restype = ctypes.POINTER(ctypes.c_double)

# Extract vectors
v1 = [lib.get_v1()[i] for i in range(3)]
v2 = [lib.get_v2()[i] for i in range(3)]

print("Vector v1 =", v1)
print("Vector v2 =", v2)
```

Python Code for Plotting

```
import ctypes
import numpy as np
import sys
import matplotlib.pyplot as plt
sys.path.insert(0, '/home/soma-harsha/Desktop/matgeo/codes/
    CoordGeo')
# Load shared library
lib = ctypes.CDLL("./libvectors.so")

# Set return types
lib.get_v1.restype = ctypes.POINTER(ctypes.c_double)
lib.get_v2.restype = ctypes.POINTER(ctypes.c_double)

from line.funcs import *
from triangle.funcs import *
from conics.funcs import circ_gen
```

Python Code for Plotting

```
# Get vectors
v1 = np.array([lib.get_v1()[i] for i in range(3)])
v2 = np.array([lib.get_v2()[i] for i in range(3)])

print("v1 =", v1)
print("v2 =", v2)

# Plot
fig = plt.figure(figsize=(8,6))
ax = fig.add_subplot(111, projection='3d')

origin = np.array([0,0,0])

# Plot vectors
ax.quiver(*origin, *v1, color='r', label="v1")
ax.quiver(*origin, *v2, color='b', label="v2")

# Line of collinearity
t = np.linspace(-2, 2, 100)
```

Python Code for Plotting

```
line = np.outer(t, v1)
ax.plot(line[:,0], line[:,1], line[:,2], 'g--', label="Line of
        Collinearity")
# Labels
ax.set_xlabel("X")
ax.set_ylabel("Y")
ax.set_zlabel("Z")
ax.set_title("Collinear Vectors from C .so File")
ax.legend()
plt.savefig('../figs/fig1.png')
plt.show()
```