Matgeo 1-1.10-28

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Question

Write down a unit vector in XY-plane, making an angle of 30° with the positive direction of X-axis.

Terms Used

Table: Terms used

Term	Description
α	Angle made by the vector with positive X-axis
β	Angle made by the vector with positive Y-axis
m	unit direction vector

Solution

In the 2D space, the unit direction vector is defined as

$$m = \begin{pmatrix} \cos \alpha \\ \cos \beta \end{pmatrix} \tag{3.1}$$

Where $\alpha.\beta$ are the angles made by the vectors with the axes.
Angle made by the unit vector in question with the positive X-axis and positive Y-axis :
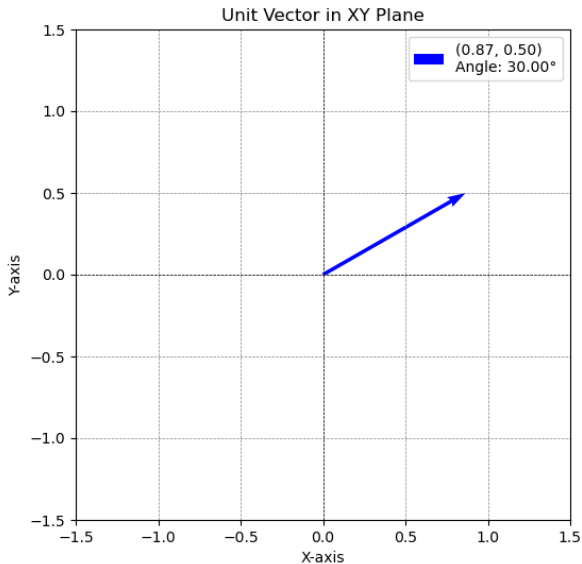
$$\alpha = 30° \tag{3.2}$$

$$\beta = 60° \tag{3.3}$$

Solution

From equation 3.1, the required unit vector is:

$$\begin{pmatrix} \frac{\sqrt{3}}{2} \\ \frac{1}{2} \end{pmatrix}$$

Plot

Unit Vector in XY Plane

C Code

```c
#include <stdio.h>
#include <math.h>
#define ANGLE 30.0
int main() {
// Convert angle to radians
double radians = ANGLE * (M_PI / 180.0);
// Calculate unit vector components
double x = cos(radians);
double y = sin(radians);
// Open file for writing
FILE *file = fopen("output.txt", "w");
if (file == NULL) {
printf("Error opening file!\n");
return 1;
}
// Write the vector components to the file
fprintf(file, "%f %f\n", x, y);
// Close the file
fclose(file);
return 0;
}
```

Python Code

```python
import numpy as np
import matplotlib.pyplot as plt

# Read the unit vector from the output.txt file
with open('output.txt', 'r') as file:
    line = file.readline()
    x, y = map(float, line.split())

# Calculate the angle of the vector in degrees
angle = np.degrees(np.arctan2(y, x))

# Plotting the vector
plt.figure(figsize=(6, 6))
plt.quiver(0, 0, x, y, angles='xy', scale_units='xy', scale=1, color='b', label=f'({x:.2f}, {y:.2f})\nAngle: {angle:.2f}°')

plt.xlim(-1.5, 1.5)
plt.ylim(-1.5, 1.5)
plt.axhline(0, color='black', linewidth=0.5, ls='--')
plt.axvline(0, color='black', linewidth=0.5, ls='--')
plt.grid(color='gray', linestyle='--', linewidth=0.5)
```

Python Code

```python
plt.title('Unit Vector in XY Plane')
plt.xlabel('X-axis')
plt.ylabel('Y-axis')

# Adding a legend
plt.legend(loc='upper right')

# Save the plot as figure1.png
plt.savefig('figure1.png')
plt.show()
```