

1.2.17

AI25BTECH11011-VARUN

August 30, 2025

Question

Three vertices of a parallelogram ABCD are $A(3,-1,2)$, $B(1,-2,4)$, $C(-1,1,2)$. Find the coordinates of the fourth vertex.

Theoretical Solution

Let the vertices of parallelogram ABCD be $\mathbf{A} \begin{pmatrix} 3 \\ -1 \\ 2 \end{pmatrix}$, $\mathbf{B} \begin{pmatrix} 1 \\ -2 \\ 4 \end{pmatrix}$, $\mathbf{C} \begin{pmatrix} -1 \\ 1 \\ 2 \end{pmatrix}$.

In any parallelogram, the diagonals bisect each other, so the midpoints of \mathbf{AC} and \mathbf{BD} are equal.

The midpoint of A and B is

$$\mathbf{M}_{AB} = \frac{\mathbf{A} + \mathbf{B}}{2} \quad (1)$$

Theoretical Solution

Midpoint of **AC**:

$$\mathbf{M}_{AC} = \frac{\mathbf{A} + \mathbf{C}}{2} \quad (2)$$

Midpoint of **BD**:

$$\mathbf{M}_{BD} = \frac{\mathbf{B} + \mathbf{D}}{2} \quad (3)$$

Theoretical Solution

As $\mathbf{M}_{AC} = \mathbf{M}_{BD}$:

$$\mathbf{A} + \mathbf{C} = \mathbf{B} + \mathbf{D} \quad (4)$$

$$\mathbf{D} = \mathbf{A} + \mathbf{C} - \mathbf{B} \quad (5)$$

$$\mathbf{D} = \begin{pmatrix} 3 \\ -1 \\ 2 \end{pmatrix} + \begin{pmatrix} -1 \\ 1 \\ 2 \end{pmatrix} - \begin{pmatrix} 1 \\ -2 \\ 4 \end{pmatrix} \quad (6)$$

$$\mathbf{D} = \begin{pmatrix} 3 + (-1) - 1 \\ -1 + 1 - (-2) \\ 2 + 2 - 4 \end{pmatrix} = \begin{pmatrix} 1 \\ 2 \\ 0 \end{pmatrix} \quad (7)$$

The fourth vertex is $\mathbf{D} \begin{pmatrix} 1 \\ 2 \\ 0 \end{pmatrix}$.

main C Code

```
#include <stdio.h>

int main() {
    double A[3] = {3, -1, 2};
    double B[3] = {1, -2, 4};
    double C[3] = {-1, 1, 2};
    double D[3];

    D[0] = A[0] + C[0] - B[0];
    D[1] = A[1] + C[1] - B[1];
    D[2] = A[2] + C[2] - B[2];

    FILE *fp = fopen("coords.dat", "w");
    if (fp == NULL) {
        printf("Error opening file!\n");
        return 1;
    }
}
```

```
fprintf(fp, "%lf %lf %lf\n", A[0], A[1], A[2]);  
fprintf(fp, "%lf %lf %lf\n", B[0], B[1], B[2]);  
fprintf(fp, "%lf %lf %lf\n", C[0], C[1], C[2]);  
fprintf(fp, "%lf %lf %lf\n", D[0], D[1], D[2]);  
  
fclose(fp);  
  
printf("Fourth vertex D: (%.2lf, %.2lf, %.2lf)\n", D[0], D  
      [1], D[2]);  
  
return 0;  
}
```



```
#include <stdio.h>

void find_fourth_vertex(double A[3], double B[3], double C[3],
    double D[3]) {
    D[0] = A[0] + C[0] - B[0];
    D[1] = A[1] + C[1] - B[1];
    D[2] = A[2] + C[2] - B[2];
}
```

Python Code

```
from ctypes import CDLL, c_double, POINTER
import numpy as np
import matplotlib.pyplot as plt

# Load the shared library
lib = CDLL("./libvertex.so")

# Define argument and return types
lib.find_fourth_vertex.argtypes = [POINTER(c_double), POINTER(
    c_double), POINTER(c_double), POINTER(c_double)]

# Define points
A = (c_double * 3)(3, -1, 2)
B = (c_double * 3)(1, -2, 4)
C = (c_double * 3)(-1, 1, 2)
D = (c_double * 3)()
```

Python Code

```
# Call the C function
lib.find_fourth_vertex(A, B, C, D)

# Convert to Python list
D_point = [D[i] for i in range(3)]
print(f"Fourth vertex D: {D_point}")

# Read coordinates from .dat file (generated by main C code)
coords = np.loadtxt("coords.dat")

# Plot the parallelogram
fig = plt.figure()
ax = fig.add_subplot(111, projection='3d')

# Points
x = coords[:, 0]
y = coords[:, 1]
z = coords[:, 2]
```

Python Code

```
# Plot parallelogram edges
ax.plot([x[0], x[1]], [y[0], y[1]], [z[0], z[1]], 'r-')
ax.plot([x[1], x[2]], [y[1], y[2]], [z[1], z[2]], 'r-')
ax.plot([x[2], x[3]], [y[2], y[3]], [z[2], z[3]], 'r-')
ax.plot([x[3], x[0]], [y[3], y[0]], [z[3], z[0]], 'r-')

# Plot diagonals
ax.plot([x[0], x[2]], [y[0], y[2]], [z[0], z[2]], 'b--')
ax.plot([x[1], x[3]], [y[1], y[3]], [z[1], z[3]], 'b--')

# Labels
ax.scatter(x, y, z, color='black')
for i, txt in enumerate(['A', 'B', 'C', 'D']):
    ax.text(x[i], y[i], z[i], txt)
plt.savefig("/home/gara-varun-kumar/ee1030-2025/ai25btech11011/
            matgeo/1.2.17/figs/Fig 1.png")
plt.show()
```

Plot

