```
projection of rA_ on rB_ = rA_.rB_/|rB|
pr of rA_ on rB_ = 128.033 (m)
```

(d) The scalar triple product, $\mathbf{r}_C \cdot (\mathbf{r}_B \times \mathbf{r}_A)$, is calculated in MATLAB with:

```
dot(rCn_,cross(rBn_,rAn_))
```

or

```
CAB=[rCn(1),rCn(2),rCn(3);
     rBn(1),rBn(2),rBn(3);
     rAn(1),rAn(2),rAn(3)];
```

and the numerical result is `rC.(rB x rA) = -2.12e+06`.

Next the vectors are plotted using MATLAB. The numerical vectors are introduces with `quiver3(x,y,z,u,v,w)` that represents the vectors as arrows with components `u,v,w` at the points `x,y,z`:

```
quiver3(0,0,0, rAn_(1),rAn_(2),rAn_(3),1,...
    'Color','r','LineWidth',1.5)
quiver3(0,0,0, rBn_(1),rBn_(2),rBn_(3),1,...
    'Color','k','LineWidth',1.5)
quiver3(0,0,0, rCn_(1),rCn_(2),rCn_(3),1,...
    'Color','k','LineWidth',1)
quiver3(0,0,0, Rn_(1),Rn_(2),Rn_(3),1,...
    'Color','b','LineWidth',2)
```

The cartesian axes are plotted with:

```
quiver3(0,0,0,sf,0,0,1,'Color','k','LineWidth',1)
quiver3(0,0,0,0,sf,0,1,'Color','k','LineWidth',1)
quiver3(0,0,0,0,0,sf,1,'Color','k','LineWidth',1)
```

The MATLAB plots are shown in Fig. 1.13.

1.13 Problems

1.1 The force $\mathbf{F}$ shown in the Fig. 1.14 has the vector components $\mathbf{F}_x$, $\mathbf{F}_y$, and $\mathbf{F}_z$ withe the magnitudes F_x, F_y, and F_z respectively. Find the direction angles θ_x, θ_y and θ_z made by the vectorial force $\mathbf{F}$ with the positive x, y, and z axes. For the numerical application use $F_x = 140$ units, $F_y = 170$ units, and $F_z = 190$ units.

1.2 The forces $\mathbf{F}_1$ and $\mathbf{F}_2$ are applied as shown in the Fig. 1.15. The force $\mathbf{F}_2$ has the magnitude F_2 and makes the angle β with the horizontal axis and the force $\mathbf{F}_1$ has the magnitude F_1. The angle between the segment AB and the force F_1 is φ and the angle between BA and the horizontal axis is denoted by θ. Determine

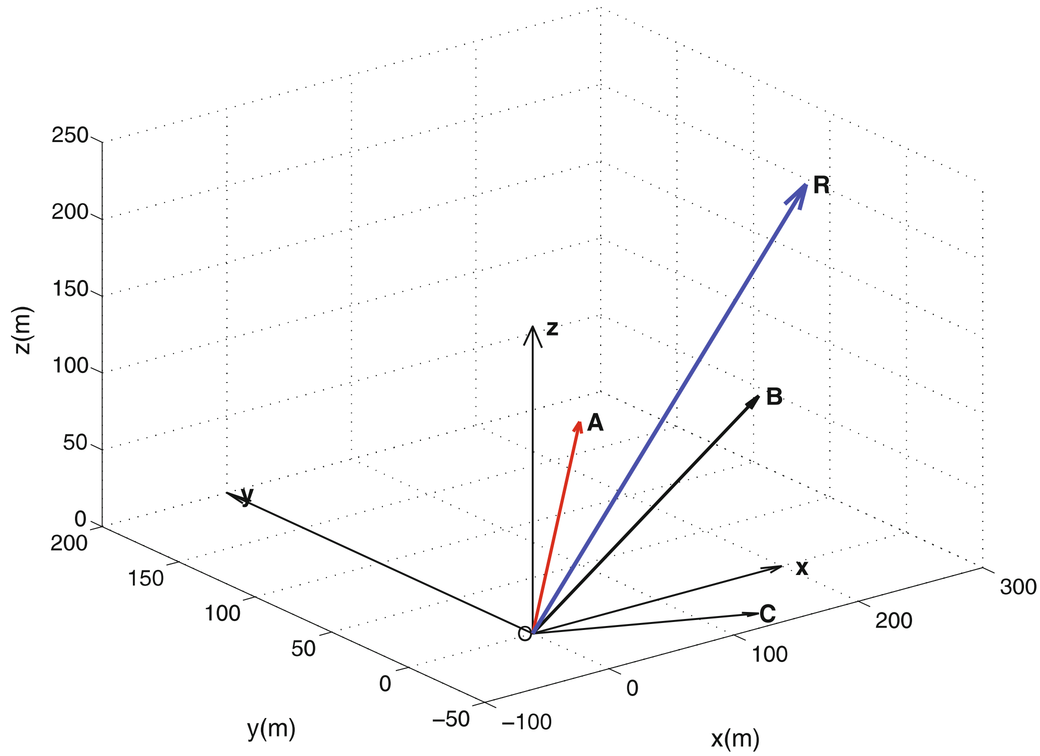
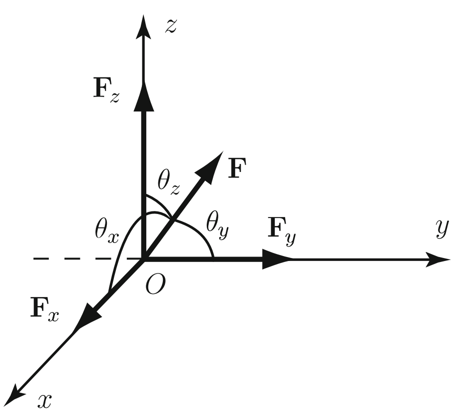


Fig. 1.13 Example 1.3: MATLAB graphical representation

Fig. 1.14 Problem 1.1



the resultant $\mathbf{F} = \mathbf{F}_1 + \mathbf{F}_2$. For the numerical application use $F_1 = 30$ units, $F_2 = 45$ units, $\theta = 105°$, $\varphi = 110°$, and $\beta = 30°$.

1.3 The following vectors are given: $\mathbf{v}_1 = 2\boldsymbol{\imath} - 3\boldsymbol{\jmath} - 7\mathbf{k}$, $\mathbf{v}_2 = 5\boldsymbol{\imath} + 4\mathbf{k}$, and $\mathbf{v}_3 = 2\boldsymbol{\imath} + 9\boldsymbol{\jmath} + 10\mathbf{k}$. Find $(\mathbf{v}_1 \times \mathbf{v}_2) \times \mathbf{v}_3$ and $(\mathbf{v}_1 \times \mathbf{v}_2) \cdot \mathbf{v}_3$.

1.4 Find the angle between the vectors $\mathbf{v}_1 = 7\boldsymbol{\imath} - 8\boldsymbol{\jmath} + 3\mathbf{k}$ and $\mathbf{v}_2 = 2\boldsymbol{\imath} + 5\boldsymbol{\jmath} + 8\mathbf{k}$. Find the expressions $\mathbf{v}_1 \times \mathbf{v}_2$ and $\mathbf{v}_1 \cdot \mathbf{v}_2$.

1.5 The following vectors are given $\mathbf{v}_1 = 3\boldsymbol{\imath} + 5\boldsymbol{\jmath} + 7\mathbf{k}$, $\mathbf{v}_2 = 2\boldsymbol{\imath} + 4\boldsymbol{\jmath} + 5\mathbf{k}$, and $\mathbf{v}_3 = -4\boldsymbol{\imath} - 4\mathbf{k}$. Find the vector triple product of $\mathbf{v}_1$, $\mathbf{v}_2$, and $\mathbf{v}_3$.

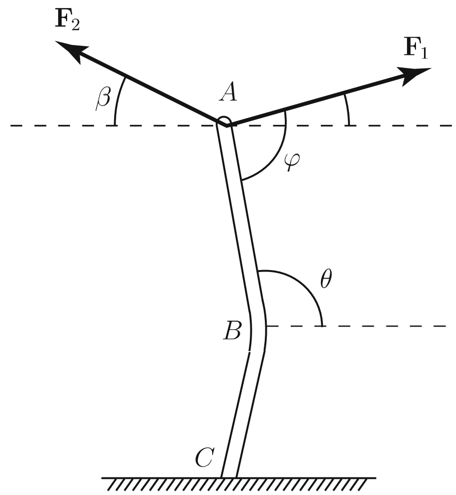


Fig. 1.15 Problem 1.2

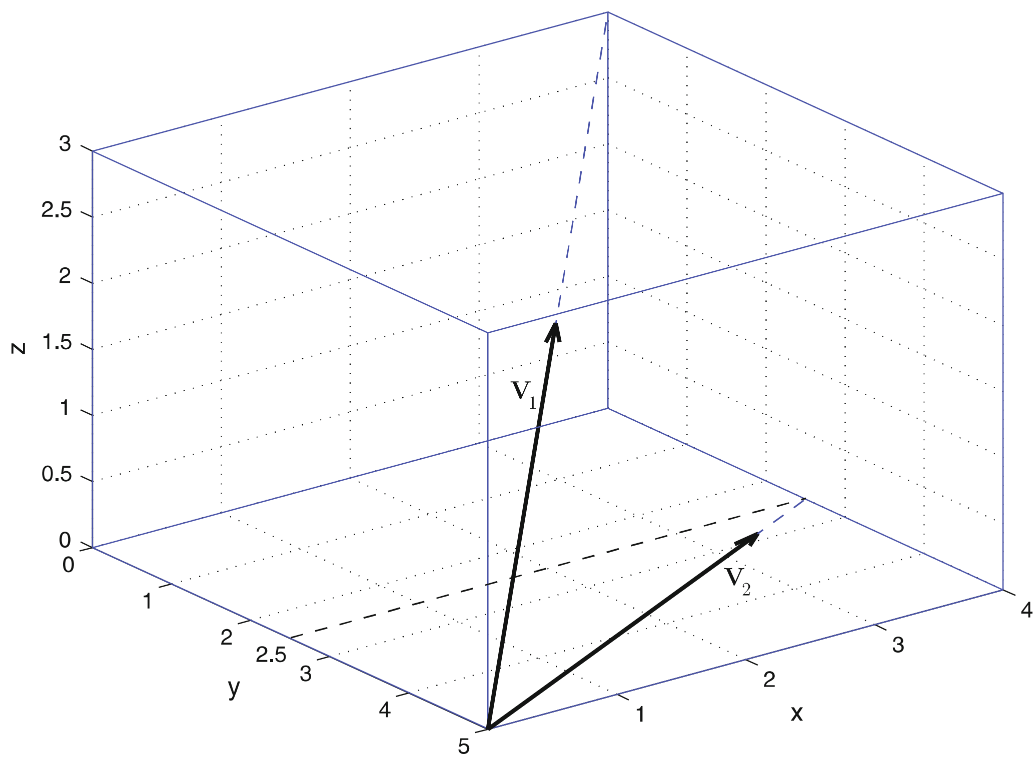


Fig. 1.16 Problem 1.6

1.6 Figure 1.16 represents the vectors $\mathbf{V}_1$ and $\mathbf{V}_2$ acting on a prism. The magnitudes of the vectors are $V_1 = V_2 = 4$ units. (a) Find the resultant and the direction cosines of the resultant. (b) Determine the angle between the vectors $\mathbf{V}_1$ and $\mathbf{V}_3$. (c) Find the projection of the vector $\mathbf{V}_1$ on the resultant vector.

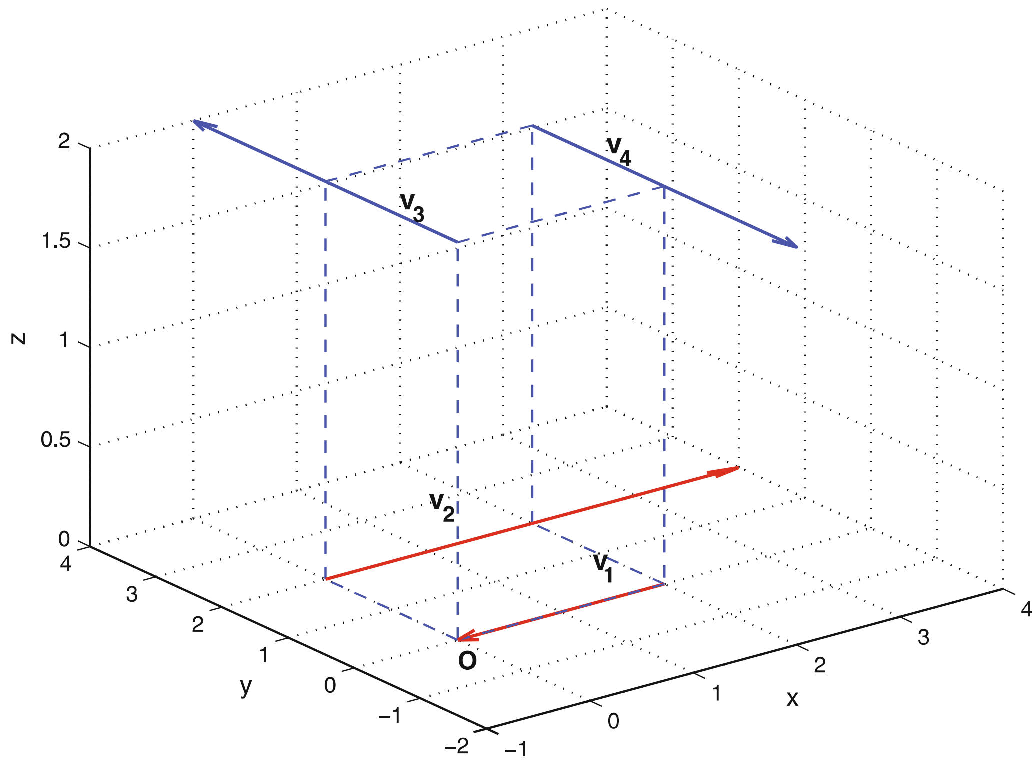


Fig. 1.17 Problem 1.7

1.7 Figure 1.17 represents the vectors $\mathbf{v}_1 = -V\boldsymbol{\imath}$, $\mathbf{v}_2 = 2\,V\boldsymbol{\imath}$, $\mathbf{v}_3 = 2\,V\boldsymbol{\jmath}$, and $\mathbf{v}_4 = -2\,V\boldsymbol{\jmath}$, where $V = 2$ units. Determine: (a) the resultant $\mathbf{v} = \mathbf{v}_1 + \mathbf{v}_2 + \mathbf{v}_3 + \mathbf{v}_4$; (b) the angle between the vectors $\mathbf{v}_1$ and $\mathbf{v}_3$; (c) the projection of the vector $\mathbf{v}_4$ on the resultant vector; (d) $\mathbf{v}_2 \cdot \mathbf{v}$; $\mathbf{v}_1 \times \mathbf{v}_2$; and $\mathbf{v}_2 \times \mathbf{v}_4$.

1.8 The magnitude of the vectors, shown in Fig. 1.18, are $F_1 = 2$ units, $F_2 = 2.5$ units, $F_3 = 3$ units, and $F_4 = 3.5$ units. (a) Find the resultant $\mathbf{F} = \mathbf{F}_1 + \mathbf{F}_2 + \mathbf{F}_3 + \mathbf{F}_4$. (b) Determine the angle between the vectors $\mathbf{F}_1$ and $\mathbf{F}_3$. (c) Find the projection of the vector $\mathbf{F}_2$ on the vector $\mathbf{F}_4$. (d) Calculate $\mathbf{F}_2 \cdot \mathbf{F}_4$; $\mathbf{F}_1 \cdot (\mathbf{F}_3 \times \mathbf{F}_1)$; $(\mathbf{F}_2 \times \mathbf{F}_3) \cdot \mathbf{F}_1$; and $[\mathbf{F}_1,\ \mathbf{F}_2,\ \mathbf{F}_3]$.

1.14 Programs

1.14.1 Program 1.1

```
% example 1.1
clear all
% clears all the objects in the MATLAB workspace and
% resets the default MuPAD symbolic engine
```