PLANES V1.10

This program from the field of Vector Algebra treats some exercises concerning a plane in combination with a straight line or a point. It determines for:
plane-plane: - if parallel, the distance or the intersection line and intersection angle,
plane – straight line: if parallel, the distance, otherwise the intersection point and intersection angle,
plane – point: the distance
The plane accepts the input for a plane either in parameter form:
E: $\boldsymbol{p} + \lambda*\boldsymbol{n} + \mu*\boldsymbol{m}$ **(I)**
($\boldsymbol{p}$: $\{p_x,p_y,p_z\}$: point in the plane, $\boldsymbol{n}$ $\{n_x,n_y,n_z\}$ and $\boldsymbol{m}$ $\{m_x,m_y,m_z\}$: vectors in the plane)
or in normal vector form:
E: $\boldsymbol{n}*(x-\boldsymbol{p})=0$ **(II)**
($\boldsymbol{n}$ $\{n_x,n_y,n_z\}$: normal or perpendicular vector, $\boldsymbol{p}$: $\{p_x,p_y,p_z\}$: point in the plane). While case **(I)** requires the input of $\boldsymbol{p}$, $\boldsymbol{n}$, and $\boldsymbol{m}$, vector $\boldsymbol{m}$ in case **(II)** has to be entered as **{0,0,0}**, cf. example 1.
If the equation of the plane is given in Cartesian coordinates as **(III)**: $\boldsymbol{a}*x + \boldsymbol{b}*y + \boldsymbol{c}*z = \boldsymbol{d}$, proceed as follows to transform it to **(II)**: the coefficients $\boldsymbol{a}$, $\boldsymbol{b}$, $\boldsymbol{c}$ are equivalent to $\{n_x,n_y,n_z\}$. Then set two values of $\boldsymbol{p}$ in advance, e.g. p_x and p_y and calculate p_z by replacing x and y in **(III)**:
$(\boldsymbol{d} - (p_x*\boldsymbol{a} + p_y*\boldsymbol{b}))/\boldsymbol{c} = p_z$. The vector $\boldsymbol{p}$ now is $\{p_x,p_y,p_z\}$.
A straight line is defined by the equation $\boldsymbol{r}+\lambda*\boldsymbol{a}$, where $\boldsymbol{r}$ is the point vector $\{r_x,r_y,r_z\}$ and $\boldsymbol{a}$ describes the direction vector $\{a_x,a_y,a_z\}$. So the entry here has to be made for $\{r_x,r_y,r_z\}$ and $\{a_x,a_y,a_z\}$.
The entry for a point P_0 has to be executed as $\{p_{0x},p_{0y},p_{0z}\}$. **Be sure to start each entry with a brace { (the }-brace may be omitted) and to enter a negative coordinate with the (-) - key !**
To run the program, press **prgm**, select **EXEC** , PLANES and press **enter**. Press **enter** again and follow the instructions for the following example.

EXAMPLE 1: Given are the planes **E1**: x + 5*y – 3*z = -2 and **E2**: {0,1,1} + λ*{-1/2,-1,1} + μ*{-5/2,1,2}. Check their properties.
First change E1 to the P,n – form **(II)**. Assume $P_{1x}=1$ and $P_{1y}=0$ and replace x and y in **(III)** by these quantities. You get $z=P_{1z}$ = (-2-(1*1+0*5))/-3 = 1. So the vector $\boldsymbol{p_1}$ = {1,0,1} , $\boldsymbol{n_1}$ = {1,5,-3} and **E1** = {1,5,-3}*(x-{1,0,1}) = 0. After you have started the program, the screen displays:
PLANE 1:
P1+ λ*{N1}+ μ*{M1}
OR IF {M1}={0,0,0}:
N1*(X-P1)=0
POINT VECTOR P1: Input: **{1,0,1 enter**
VECTOR N1: Input: **{1,5,-3 enter**
VECTOR M1: Input: **{0,0,0 enter**. Now the program prompts to enter the next figure:
SELECT
1:PLANE-PLANE
2:PLANE-LINE
3:PLANE-POINT
Press enter or **1** (default) and continue:
PLANE 2:
P2+ λ*{N2}+ μ*{M2}
OR IF {M2}={0,0,0}:
N2*(X-P2)=0
POINT VECTOR P2: Input: **{0,1,1 enter**
VECTOR N2: Input: **{-1/2,-1,1 enter**
VECTOR M2: Input: **{-5/2,1,2 enter**

The result is:
SECTION LINE: R+μ*A
R: {0 , 5/13 , 17/13}   (------> stored in list $_L$H)
A: {-39/2 , 12 , 27/2}   (------> stored in list $_L$Q)
α°: 86° 46′ 12.137″   (Planes are not parallel !)
The equation of the straight line of intersection L_1 is :   {0 , 5/13 , 17/13} + μ*{-39/2 , 12 , 27/2}=
{-39/2*μ , 5/13+12*μ , 17/13+27/2*μ}.

EXAMPLE 2:
Check the condition between plane **E1**: p1={1,5,2}, n1={2,1,3} and line **G1**: {0,1,-1} + λ*{-1,-4,2}.
Start the program and make the following inputs:
PLANE 1:
P1+ λ*{N1}+ μ*{M1}
OR IF {M1}={0,0,0}:
N1*(X-P1)=0
POINT VECTOR P1:   Input: **{1,5,2 enter**
VECTOR N1: Input: **{2,1,3 enter** . Now the program prompts to select figure 2:
VECTOR M1: Input: **{0,0,0 enter**
SELECT
1:PLANE-PLANE
2:PLANE-LINE
3:PLANE-POINT
Press **2** and continue:
STRAIGHT LINE: R+λ*A
POINT VECTOR R: Input: **{0,1,-1 enter**
DIRECTION VECTOR A: Input: **{-1,-4,2 enter**
Result:
PLANE AND LINE PARALLEL!
DISTANCE: 4.0089186

Claus M. Dachselt