GMT225 REFERENCE COORDINATE SYSTEMS

Assignment 2 - Rotation

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Part II – Explanation

First of all, I defined the “[nvec] = rotation(vec,ang,ax)” function specified in the assignment for the function I will write in MATLAB. The reason why I designed the homework in MATLAB, I designed it in matlab because I know that this function will perform the necessary matrix operations in a short way and reliably. In the next step after defining the function, I created my rotation matrices according to the X, Y, Z coordinates. While creating the matrices, I analyzed our shape in assignment 2 and found that it was “Right-Handed Coordinate System”. So I created my matrices by referencing the right hand coordinate system. In addition, I applied the "cosd and sind" commands to process my angles in the matrix in degrees. Then, I applied the numbering (1,2,3) operation to the axes in our function as described in the homework. Then, I specified on which axis the "ax" input should take place in the problem we want to solve with the "if, elseif" conditions, and I performed the matrix multiplication of the rotation matrices I created, respectively, with the 3x1 matrix that we will enter on these axes. Finally, I created the function to calculate all kinds of inputs, but if I enter the entries in section 1 of the assignment in order, the input "rotation ([100;120;200],-20,2)" tells us the following. In the order “(vec,ang,ax)” we enter our vector given in Part I, respectively, then we enter our angle as “λ=-20” clockwise (-) and finally our axis will be “ 2 ”, that is, on the Y axis. We enter it and print it in the command window. If I interpret the "rotation (ans,25,3)" entry, we enter the results of the first rotated axis as vectors, then we enter our angle as the angle "δ=25" counterclockwise (+), and finally our axis is "3", that is Z. We enter it on the axis and print it in the command window. If I interpret the “rotation(ans,7,2)” input, we enter the results on the second rotated axis as vectors, then we enter our angle as “β=7” angle counterclockwise (+), finally our axis is “2”, that is Y. We enter it on the axis and print it in the command window.

In addition to these, my Matlab code in Part II is given below as “Figure 1” and its output is “Figure 2”. Also, to confirm the results of my matlab code, I manually solved the Part I problem and shared it as "Figure 3" below.

```
% Abdulsamet Toptaş - 21905024
% I created rotation function.
function [nvec] = rotation(vec,ang,ax)

% As stated in the assignment, I created the rotation matrices as 3x3.
% Matrices reference the "Right-Handed Coordinate System".
% R1 For X Matrix , R2 For Y Matrix , R3 For Z Matrix
R1 = [1,0,0;0,cosd(ang),sind(ang);0,-sind(ang),cosd(ang)];
R2 = [cosd(ang),0,-sind(ang);0,1,0;sind(ang),0,cosd(ang)];
R3 = [cosd(ang),sind(ang),0;-sind(ang),cosd(ang),0;0,0,1];

% ('ax==1' For X axis)
if ax == 1
    nvec = R1*vec;
% ('ax==2' For Y axis)
elseif ax == 2
    nvec = R2*vec;
% ('ax==3' For Z axis)
elseif ax == 3
    nvec = R3*vec;
end

end
% COMMAND WINDOW ENTRY = rotation([100;120;200],-20,2) --> It will rotate clockwise(-) by an angle λ on the Y axis.
% COMMAND WINDOW ENTRY = rotation(ans,25,3) --> It will rotate counter-clockwise(+) by an angle δ on the Z axis.
% COMMAND WINDOW ENTRY = rotation(ans,7,2) --> It will rotate counter-clockwise(+) by an angle β on the Y axis.
```

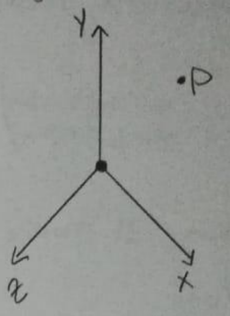
(Figure 1 : Code)

```
rotation.m
Command Window
New to MATLAB? See resources for Getting Started.
>> rotation([100;120;200],-20,2)

ans =

  162.3733
  120.0000
  153.7365

>> rotation(ans,25,3)

ans =

  197.8744
   40.1350
  153.7365

>> rotation(ans,7,2)

ans =

  177.6637
   40.1350
  176.7054

>>
```

(Figure 2 : Output)

= PART I =

Figure in the assignment 2
Right-Handed Coordinate System



$r_{p}' = R_N \, r_p$

* Rotation X Matrix For Axis 1 (3x3)

$$R_1 = \begin{pmatrix} 1 & 0 & 0 \\ 0 & \cos(ang) & \sin(ang) \\ 0 & -\sin(ang) & \cos(ang) \end{pmatrix}$$

* Rotation Y Matrix For Axis 2 (3x3)

$$R_2 = \begin{pmatrix} \cos(ang) & 0 & -\sin(ang) \\ 0 & 1 & 0 \\ \sin(ang) & 0 & \cos(ang) \end{pmatrix}$$

* Rotation Z Matrix For Axis 3 (3x3)

$$R_3 = \begin{pmatrix} \cos(ang) & \sin(ang) & 0 \\ -\sin(ang) & \cos(ang) & 0 \\ 0 & 0 & 1 \end{pmatrix}$$

*

Y-axis through an angle λ clockwise (−)

Z-axis through an angle δ counter-clockwise (+)

Y-axis through an angle β counter-clockwise (+)

*Matrices reference the "Right-Handed Coordinate System".

* => $X_P = 100$, $Y_P = 120$, $Z_P = 200$

* => $\lambda = 20°$, $\delta = 25°$, $\beta = 7°$

CALCULATIONS *(Calculations are made in degrees)

For Y-axis an angle λ clockwise (−)

$$R_2 \begin{pmatrix} x' \\ y' \\ z' \end{pmatrix} = \begin{pmatrix} \cos(-20) & 0 & -\sin(-20) \\ 0 & 1 & 0 \\ \sin(-20) & 0 & \cos(-20) \end{pmatrix} \cdot \begin{pmatrix} 100 \\ 120 \\ 200 \end{pmatrix} = \begin{pmatrix} 100 \times \cos(-20) - 200 \times \sin(-20) \\ 120 \\ 100 \times \sin(-20) + 200 \times \cos(-20) \end{pmatrix}$$

$$\approx \begin{pmatrix} 162.373290 \\ 120 \\ 153,736509 \end{pmatrix}$$

For Z-axis an angle δ counter-clockwise (+)

$$R_3 \begin{pmatrix} x' \\ y' \\ z' \end{pmatrix} = \begin{pmatrix} \cos(25) & \sin(25) & 0 \\ -\sin(25) & \cos(25) & 0 \\ 0 & 0 & 1 \end{pmatrix} \cdot \begin{pmatrix} 162.3733 \\ 120 \\ 153,7365 \end{pmatrix} = \begin{pmatrix} 162,3733 \times \cos(25) + 120 \times \sin(25) \\ -162.3733 \times \sin(25) + 120 \times \cos(25) \\ 153,7365 \end{pmatrix}$$

$$\approx \begin{pmatrix} 197,874377 \\ 40,135012 \\ 153,7365 \end{pmatrix}$$

For Y-axis an angle β counter-clockwise (+)

$$R_2 \begin{pmatrix} x' \\ y' \\ z' \end{pmatrix} = \begin{pmatrix} \cos(7) & 0 & -\sin(7) \\ 0 & 1 & 0 \\ \sin(7) & 0 & \cos(7) \end{pmatrix} \cdot \begin{pmatrix} 197,8744 \\ 40,1350 \\ 153,7365 \end{pmatrix} = \begin{pmatrix} 197,8744 \times \cos(7) - 153,7365 \sin(7) \\ 40,1350 \\ 197,8744 \times \sin(7) + 153,7365 \cos(7) \end{pmatrix} \approx \begin{pmatrix} 177,6637 \\ 40,1350 \\ 176,7056 \end{pmatrix}$$

(Figure 3 : Manual Solution)