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To verify this equation



**The first solution**

We do these procedures.

From front of picture, we rotate A about a unit vector  by  same as we rotate A about  by  and rotate this obtained frame about  by -, keep rotating about () by , rotate the already obtained frame about  by -, and finally rotate the already obtained frame about  by -.

So we have

from front of picture we have



From (1) and (2), we have the proof.

About the calculating , it’s easy to prove, just take note 

**The second solution:**



This solution is similar to the first solution but it’s easy to calculate the value of R, because we have some changes in rotating.





 



 

 

 

 



  

  



 

 

 



 

 

 

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| i |  |  |  |  |
| 1 | 0 | 0 | 0 |  |
| 2 | 90 | 0 | 0 |  |
| 3 | 90 | 0 |  |  |
| 4 | -90 | 0 |  |  |
| 5 | 90 | 0 |  |  |
| 6 | 0 | 0 |  |  |

Note: 





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To find the angles  for the elbow manipulator given , we consider the plane formed by the second and third links as shown in this Figure. Since the motion of links two and three is planar, the solution is analogous to that of the two-link manipulator of the first exercise. So we have



Similarity we can find  as





Based on this figure, , the first joint variable, is the base rotation and solution given as:

 provided are not both zero. In case both  are zero, we have a second solution for is given by

From this figure, we have where 

and 