BIRZEIT UNIVERSITY

Faculty of Engineering and Technology

Electrical and Computer Engineering Department

Electromagnetics 1 (ENEE 3408)

Assignment #1 Vector Analysis

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Section No. 1

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April 2020

Question: Given the vectors

$$R_1 = \hat{a}_x + 2\hat{a}_y + 3\hat{a}_z$$

$$R_2 = 3\hat{a}_x + 2\hat{a}_y + \hat{a}_z$$

Find:

a) The dot product $(R_1 \cdot R_2)$

b) The projection of R_1 on R_2

c) The angle between R_1 and R_2

d) Write a MATLAB program to verify your answer

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a) The dot product of the two vectors can be calculated by :

$$R_1 \cdot R_2 = R_{1x}R_{2x} + R_{1y}R_{2y} + R_{1z}R_{2z}$$

$$R_1 \cdot R_2 = (1)(3) + (2)(2) + (3)(1)$$

$$R_1 \cdot R_2 = 10$$

b) The projection of R_1 on R_2 is calculated using the following formula:

$$\text{proj}_{R_2}R_1 = \frac{R_1 \cdot R_2}{R_2 \cdot R_2}R_2$$

$$\text{proj}_{R_2}R_1 = \frac{10}{9+4+1} = \frac{10}{14}(3\hat{a}_x + 2\hat{a}_y + \hat{a}_z)$$

$$\text{proj}_{R_2}R_1 = (2.1428)\hat{a}_x + (1.4286)\hat{a}_y + (0.714)\hat{a}_z$$

c) The angle between R_1 and R_2 can be calculated from the dot product formula:

$$R_1 \cdot R_2 = |R_1||R_2|\cos(\theta_{12})$$

$$\cos(\theta_{12}) = \frac{R_1 \cdot R_2}{|R_1||R_2|}$$

$$\theta_{12} = \cos^{-1}\left(\frac{R_1 \cdot R_2}{|R_1||R_2|}\right)$$

So now we just need to substitute the numbers in the equation

$$|R_1| = \sqrt{1+4+9} = \sqrt{14}$$

$$|R_2| = \sqrt{9+4+1} = \sqrt{14}$$

$$\theta_{12} = \cos^{-1}\left(\frac{10}{14}\right) = 44.41°$$

d) The following MATLAB code verify the previous answers:

```
O  = [0 0 0];        %the origin
R1 = [1 2 3];        %vector R1
R2 = [3 2 1];        %vector R2

Dot_Product1 = dot(R1,R2)     %the dot product of the two vectors
Dot_Product2 = dot(R2,R2);    %the dot product of R2 vector with itself

Proj = (Dot_Product1/Dot_Product2)*R2   %the projection of R1 ON R2

Mag_R1 = norm(R1);      %the magnitude of R1
Mag_R2 = norm(R2);      %the magnitude of R2

Cos_theta = Dot_Product1/(Mag_R1*Mag_R2);   %the cos of the angle
                                              between R1 and R2
Theta = acosd(Cos_theta)   %the angle between R1 and R2
```

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Answers:

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Dot_Product1 = 10

Proj = (2.1429    1.4286    0.7143)

Theta = 44.4153
```