HW 1

1a

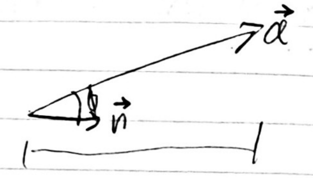
$P = \sin(\theta)\,|\vec{c}|$

$A = |\vec{b}|\,|\vec{c}|\,\sin(\theta)$

$\boxed{= |\vec{b} \times \vec{c}|}$

b. $\vec{n} = \boxed{\dfrac{\vec{b} \times \vec{c}}{|\vec{b} \times \vec{c}|}} = \dfrac{\vec{b} \times \vec{c}}{A}$

c.



$\cos(\phi)\,|\vec{a}| = h$

$\boxed{\vec{a} \cdot \vec{n}} = \cos(\phi)\,|\vec{a}|\,|\vec{n}| = \cos(\phi)\,|\vec{a}| = h$

d. $V = A \cdot h = |\vec{b} \times \vec{c}| \left(\vec{a} \cdot \dfrac{\vec{b} \times \vec{c}}{|\vec{b} \times \vec{c}|}\right) = \boxed{\vec{a} \cdot (\vec{b} \times \vec{c})}$

e. $A_2 = |\vec{c} \times \vec{a}|$, $\vec{n}_2 = \dfrac{\vec{c} \times \vec{a}}{A}$, $h_2 = \vec{b} \cdot \vec{n}_2$

$V_2 = |\vec{c} \times \vec{a}| \left(\vec{b} \cdot \dfrac{\vec{c} \times \vec{a}}{|\vec{c} \times \vec{a}|}\right) = \boxed{\vec{b} \cdot (\vec{c} \times \vec{a})}$

f. $V = \text{const} = \boxed{\vec{b} \cdot (\vec{c} \times \vec{a}) = \vec{a} \cdot (\vec{b} \times \vec{c}) = \vec{c} \cdot (\vec{a} \times \vec{b})}$

```
close all;
clear all;
clc
```

Problem 2 Part1

```
syms a b c [3 1] % genererate 3 symbolic "vectors"

ax = joshCross(a); % call a function that creates the "cross" matrix from a
 vector
bx = joshCross(b);
cx = joshCross(c);

LHS = ax*bx*c; % set LHS and RHS to the equation I want to prove
RHS = (c.'*a)*b-(b.'*a)*c;

LHS = expand(LHS); % distrubute terms so that isequal will work. This wont
 change the logic of the expressions
RHS = expand(RHS);

disp("By using symbolic math toolbox, I was able to show that right hand side
 = left hand side where, LHS = ax*bx*c; RHS = (c.'*a)*b-(b.'*a)*c. Below is
 the displayed result of the isequal function, which will return one if the
 two arguments are the same and 0 if they are different, called with the
 parameters of RHS and LHS.")
disp("RHS == LHS?")
disp(isequal(RHS, LHS)) % check if the expressions are the same

clear LHS RHS
```

```
By using symbolic math toolbox, I was able to show that right hand side =
 left hand side where, LHS = ax*bx*c; RHS = (c.'*a)*b-(b.'*a)*c. Below is
 the displayed result of the isequal function, which will return one if the
 two arguments are the same and 0 if they are different, called with the
 parameters of RHS and LHS.
RHS == LHS?
   1
```

Part2

```
LHS = a.'*bx*c; % set LHS and RHS to the equation I want to prove
RHS = b.'*cx*a;

LHS = expand(LHS); % distrubute terms so that isequal will work. This wont
 change the logic of the expressions
RHS = expand(RHS);

disp("This problem was solved in the same way as the prior but LHS = a.'*bx*c;
 RHS = b.'*cx*a.")
disp("RHS == LHS?")
```

```
disp(isequal(RHS, LHS)) % check if the expressions are the same
```

```
This problem was solved in the same way as the prior but LHS = a.'*bx*c; RHS =
 b.'*cx*a.
RHS == LHS?
   1
```

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```
function mx = joshCross(m)
arguments
    m (3,1) sym
end
    syms mx [3 3]
    for i = 1:3
        mx(i,i) = 0;
    end
    mx(1,2) = -m(3);
    mx(1,3) =  m(2);
    mx(2,3) = -m(1);

    mx(2,1) =  m(3);
    mx(3,1) = -m(2);
    mx(3,2) =  m(1);
end
```

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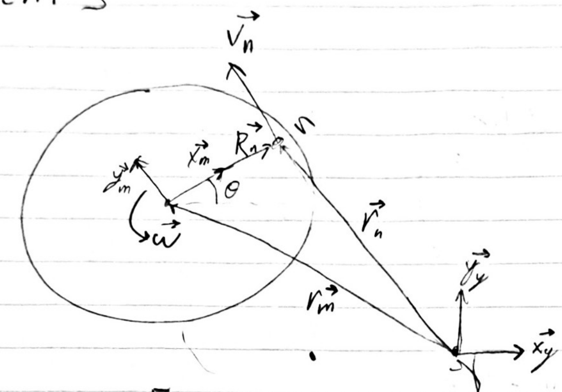
HW1

Problem 3



a) $\vec{R}_n = \vec{x}_m R_n$

$$\underline{R_{n,m}} = \begin{pmatrix} R_n \\ 0 \\ 0 \end{pmatrix}$$

$$\vec{\omega} = \vec{\mathcal{F}}_y^T \underline{\omega_y} = \vec{\mathcal{F}}_m^T \underline{\omega_m}$$

$|\underline{\omega_m}| = 0$

$|\underline{\omega_y}|$ is given

b) $$\underline{C_{my}(\theta)} = \begin{bmatrix} \cos\theta & \sin\theta & 0 \\ -\sin\theta & \cos\theta & 0 \\ 0 & 0 & 1 \end{bmatrix}$$

c) $\vec{r}_n = \vec{r}_m + \vec{R}_n$

$\underline{r_{m,y}}$ & $\underline{R_{n,m}}$ are given but $\vec{r}_n$ unknown $\vec{\mathcal{F}}_y$ $\vec{\mathcal{F}}_m$ are given. The process will be in putting $\vec{r}_m$ & $\vec{R}_n$ in same $\vec{\mathcal{F}}$ to be added together to get by components to get $\vec{r}_n$

$$\cancel{C_{ym}(\theta)} = \underline{C_{my}(\theta)}^T = \begin{bmatrix} \cos\theta & -\sin\theta & 0 \\ \sin\theta & \cos\theta & 0 \\ 0 & 0 & 1 \end{bmatrix}$$

$$\underline{R_{n,y}} = \underline{C_{ym}} \cdot \underline{R_{n,m}} = \begin{pmatrix} R_{n,mx}\cos(\theta) - R_{n,my}\sin(\theta) \\ R_{n,my}\cos(\theta) + R_{n,mx}\sin(\theta) \\ R_{n,mz} \end{pmatrix}$$

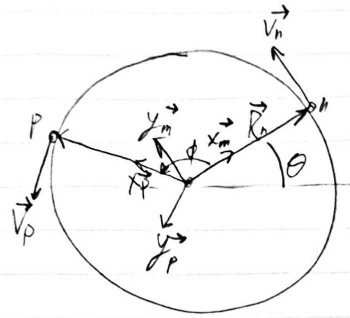
$$\vec{V}_n = \vec{\mathcal{F}}_m^T \underline{V_{n,m}} = |\omega_m| |\vec{R}_n| \vec{y}_m$$

$$\underline{V_{n,m}} = \begin{pmatrix} 0 \\ |\omega_m| \cdot R_n \\ 0 \end{pmatrix} = \begin{pmatrix} 0 \\ 0 \\ 0 \end{pmatrix}$$

$\underline{\omega_m} \Rightarrow \underline{\omega_y}$

$$\underline{V_{n,y}} = \underline{C_{ym}} \; \underline{V_{n,m}} = \begin{pmatrix} -|\omega_y| R_n \sin\theta \\ |\omega_y| R_n \cos\theta \\ 0 \end{pmatrix}$$

e



assuming second person, P, is same radius as neice

$$\vec{V}_{n/p} = \vec{V}_n - \vec{V}_p$$

$$\underline{V}_{n,m} = \begin{pmatrix} 0 \\ |\underline{\omega}_m| R_n \\ 0 \end{pmatrix} = \begin{pmatrix} 0 \\ 0 \\ 0 \end{pmatrix}$$

$$\underline{\omega}_m = \underline{\omega}_p$$

$$\underline{V}_{p,p} = \begin{pmatrix} 0 \\ |\underline{\omega}_p| R_n \\ 0 \end{pmatrix} = \begin{pmatrix} 0 \\ 0 \\ 0 \end{pmatrix}$$

$$\underline{C}_{pn}(\phi) = \begin{bmatrix} \cos\phi & \sin\phi & 1 \\ -\sin\phi & \cos\phi & 1 \\ 1 & 1 & 0 \end{bmatrix}$$

neices velocity from second refference frame F_p

↳ $\underline{V}_{n,p} = \underline{C}_{pn} \cdot \underline{V}_{n,m} = \begin{pmatrix} 0 \\ 0 \\ 0 \end{pmatrix}$

This makes sense since neither P nor n is moving through F_p or F_m