EVOLVING DOCUMENT

ME 4710/5710 Applie Dynamics Homework

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For each problem attempt to write a self-complete solution. This includes a *brief* problem restatement and gives a solution that would convince a skeptical student who didn't understand the problem.

1. 3D. Get good at vectors. Assume that the positions relative to an origin of four random points, which are randomly located in space are given as $\vec{r}_{\mathrm{A}}, \vec{r}_{\mathrm{B}}, \vec{r}_{\mathrm{C}}$ and $\vec{r}_{\mathrm{D}}$. Assume force $\vec{F}$ is given. For each problem below write a single vector formula (one for each problem) that answers the question. In all of these problems the formula evaluates to a scalar.

a) The points A and B define an infinite line. So do the points C and D. Find the distance between these two lines ('the' distance means 'the minimum distance').

b) Find the volume of the tetrahedron ABCD (you should reason-out and not quote any formulas for the volume of a tetrahedron).

c) Assume points A, B and C are fixed to a structure. All three are connected by massless rods, the a ball and socket at each end, to point D. At point D the force $\vec{F}$ is applied. Find the tension in bar AD.

2. The geometric definition of cross product is this $\vec{a} \times \vec{b}$ is a vector $\vec{c}$ with magnitude $|\vec{a}||\vec{b}|\sin\theta_{ab}$ that is orthogonal to $\vec{a}$ and $\vec{b}$ in the direction given by the right hand rule. Use this definition to find an alternative geometric definition involving projection. Use that definition to show the distributive rule $\vec{a} \times (\vec{b} + \vec{c}) = \vec{a} \times \vec{b} + \vec{a} \times \vec{c}$. Then use the distributive rule to find the component formula for cross product, namely that

$$\vec{a} \times \vec{b} = (a_2 b_3 - a_3 b_2)\hat{e}_1 + (a_3 b_1 - a_1 b_3)\hat{e}_2 + (a_1 b_2 - a_2 b_1)\hat{e}_3.$$

Hint: You can read about this in, say, the Ruina/Pratap book (box 2.7).

3. Practice a bit with dyadics. Read as much as you like, and do the exercises in course in 2.13 and 2.14: **Paul Mitiguy**'s Stanford course.