

Muddy Card Responses Lecture M3

Can you describe what the physical meaning of a moment is, and how do you choose \mathbf{r} in $\mathbf{r} \times \mathbf{F}$. A moment (or more correctly a moment of a force) is the effect of a force acting about an axis to cause an angular acceleration (or rotation). \mathbf{r} is to some extent arbitrary. It is the position vector of some point on the line of application of the force \mathbf{F} .

Why is it that a moment at the corner of the box is the same as that moment at the origin. This is a key concept in this lecture. Namely that a pure moment (such as caused by a couple - a pair of forces) is a vector quantity that does not vary with its point of application. A moment due to a force acting at a distance, has to be represented by a force and a moment, and in general these will vary with the point of application.

Difference between a torque and bending force. A torque (or twisting moment) has a vector aligned with the structural axis (the wing in the example in class) the bending moment is the component of the moment vector that is orientated perpendicular to the structural axis.

Can you give an example of transforming axes numerically. We will revisit this in a few weeks time.

Can you have a different angle between x_1 and \tilde{x}_1 , x_2 and \tilde{x}_2 and x_3 and \tilde{x}_3 ? In other words does your new system have to all be at right angles? Yes. We are dealing with cartesian coordinate systems here, otherwise direction cosines (or scalar products) would not be useful concepts.

So is the moment due to a "couple" of forces ($\mathbf{C} = \mathbf{r} \times \mathbf{F}$) always equal to $\mathbf{r} \times \mathbf{F}$ around every point in space? Yes. Note that \mathbf{r} is the position vector defining the relative position of points on the lines of action of the two forces.

The discussion of pure moments is unclear. How can there be moments if there is no force acting? This is the key point of the lecture. A pure moment arises if there are a pair of equal and opposite forces, that have parallel (but not coincident) lines of action. The distance between the lines of action defines the moment arm. The fact that the forces are equal and opposite implies that there is no net force, but that there is a net moment. This is an important concept that we will utilize repeatedly. It is worth spending the time to understand it. (there were several comments along this same idea).

2nd concept about moment addition. Why was there no \mathbf{r} ? For the reasons given above. We can represent couples $\mathbf{r} \times \mathbf{F}$ as a "pure moment" in which the point of application does not change the magnitude or direction of the resulting moment.

Can you explain in detail how to determine the direction of a cross product? Yes, please come and talk to me. We will also cover this in recitation on Tuesday.

At some point I think that you told someone not to use the right hand rule for to $\mathbf{r} \times \mathbf{F}$, what do we use instead? I did not explain this particularly clearly. What I picked up from Monica's explanation was that she had used the picture to visualize the moment and had applied the right hand rule to determine its direction. My reply was that I would prefer you

to write down the vectors for the force and position, and evaluate $\mathbf{r} \times \mathbf{F}$ in order to obtain the moment. Trying to visualize the directions of moments or forces is a useful check on your Math. However, my experience is that people get into difficulties when they overly rely on visualization. The right hand rule certainly does apply.

What was going on with your moment examples with the cube and 3-D axis. Did not even know where to begin? We will be posting the concept questions with these muddied responses. Please take the time to look at them again. If they still do not make sense, then please come and talk to me or the TA's. We can review the basics of vector manipulation for you.

In concept question 5 moments were shown, but no forces. Can a moment exist without a force? Absolutely, if it is a couple (i.e a pair of equal and opposite forces with a moment arm between them).

Are there supplements to learn how to find the momentum of forces acting on a point. I'm really rusty? We will do some revision in next week's problem sets and also cover this in recitation. Reviewing your 8.01 notes would be appropriate.

Does the double arrow only represent pure moments? Or can it represent moments caused by forces that are not balanced. This is with reference to one of the concept questions (Q4 I think) I will only use a double arrow to represent a pure moment.

Can you define the importance of the transformation matrix We will discuss this further when we get on to stress and strain.

Is \mathbf{R} a location or force vector? I will generally use capital letters for forces and moments and lower case for position vectors or displacements.