Lab Report #3: Lab # 6, Problem #3

Due Friday November 15th, 2013 at 5pm

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Assignment:

Option 1:

If you had time in class to analyze the video of the rotating disk AND measure the linear acceleration of the hanging object, then please follow what is stated in the lab manual. I've reproduced the necessary information for the assignment below.

From the Introduction:

> *To see if this design is feasible you must determine the relationship between the angular acceleration of the flywheel, the downward acceleration of the block, and the radius of the ring.*

From the analysis section:

> *From the analysis of the video data for the tape on the string, determine the acceleration of the piece of tape on the string. Compare this acceleration to the hanging object's acceleration determined directly. Be sure to use an analysis technique that makes the most efficient use of your data and your time.*
>
> *From your video data for the disk, determine if the angular speed of the disk is constant or changes with time.*
>
> *Use the equations that describe the measured components of the velocity of a point at the edge of the disk to calculate the tangential acceleration of that point and use this tangential acceleration of the edge of the disk to calculate the angular acceleration of the disk (it is also the angular acceleration of the spool). You can refer to the warm up questions.*

From the conclusion section:

> *Did your measurements agree with your initial prediction? Why or why not? What are the limitations on the accuracy of your measurements and analysis? Explain why it is not difficult to keep the string taut in this measurement by considering the forces exerted on each end of the string?*

Basically, what I'm looking for here is what is

$$\frac{a_{tangential}}{a_{linear}}.$$

where $a_{tangnetial}$ is the tangential acceleration of a point on disk. You should be able to get a "theoretical value" in terms of the radius of the spool and the radius of the disk, and you should also be able to get a measured value from the values you report. Do they match to within uncertainty? If not, make any qualitative statements you can (i.e. "a_t should have been bigger than a_{linear} and it was")? The values you should formally report are:

- $\frac{a_{tangential}}{a_{linear}}$ for both theoretical and measured values.
- The x and y components (which are time dependent) AND magnitude (which should be constant) of the tangential acceleration of a point on the disk.
- The angular acceleration of the point on the disk (and, therefore, the spool).
- The tangential acceleration of a point on the spool.
- Discuss how this tangential acceleration of a point on the spool is related to the acceleration of a point on the string (*hint*: think about it in terms of the point on the string that is JUST leaving the spool! If you're having trouble with this one please ask me).

Option 2:

If you did not have time in class to measure the linear acceleration of the hanging object, then I would like to dig a little bit deeper into the circular motion part of the lab.

REPORT AND DISCUSS EACH OF THE FOLLOWING:

1. The x and y components (which are time dependent) AND magnitude (which should be constant) of the tangential acceleration of a point on the disk.
2. A theoretical value of
$$\frac{a_{tangential}}{a_{linear}}$$
where $a_{tangential}$ is the tangential acceleration of a point on the disk!
3. Discuss how the tangential acceleration of a point on the spool is related to the acceleration of a point on the string (*hint*: think about it in terms of the point on the string that is JUST leaving the spool! If you're having trouble with this one please ask me)

4. Discuss the internal consistency of your fit values for the components of the velocity. For example, if you have an equation of the form

$$v_x = -r_{disk}(\omega_0 + \alpha t)\sin\left[\theta_0 + \omega_0 t + \frac{1}{2}\alpha t^2\right]$$

then you would fit it in motion lab with

$$v_x = A + (Bt + C)\sin\left[D + Et + Ft^2\right].$$

Therefore, for example, it SHOULD be true that

$$\begin{aligned} \omega_0 &= E \\ \omega_0 &= -\frac{C}{r_{disk}} \\ \Rightarrow E &= -\frac{C}{r_{disk}}. \end{aligned}$$

   (a) Do E and B satisfy this relationship?
   (b) What other relationships can you find algebraically and are they supported by your data?
   (c) If some these relationships aren't satisfied, TRY to explain why they might not. There are plenty of reasons why this might not be the case. If you are stuck on this then please ask me for help

Finally, from the conclusion section

> *What are the limitations on the accuracy of your measurements and analysis? Explain why it is not difficult to keep the string taut in this measurement by considering the forces exerted on each end of the string?*