Frames Edit Log 2012 8.3.12

This file used to be called proofing frames.doc, and it has notes on many proofings that took place in 2012. Today is 11.18.16 and I am reading the doc as part of my Goldstein Ch 4 review.

8.3.12.

I just finished updating Problem 3, and will now proof Problems 1 and 2.

8.4.12.

Had a big Paradox regarding $v_r = v'_r$ and resolved it. Then did a rewrite of Section 14 on curvilinear coordinates and just got that done.

I think the idea of extending things to special relativity should wait until I run into that subject somewhere, I don't want to tackle it on my own right now. Same for general relativity. So there are really no new sections to add except an introduction.

8.5.12

Did a very careful proofing of all of **Section 1**. This stuff I think is "very good". I have never seen these topics discussed this carefully in any book. I hope others will agree. Have not done "we removal", just doing the logic, checking equation references, etc.

Did careful proofing of **Section 2**. Added Hunt and Crowe references, so just starting to build the list of references. Section 2 is long winded but I think the extra words and steps are worth it since the G Rule is so fundamentally important.

Did careful proofing of **Section 3**, think this detail of what the Observer in Frame S' can see and do is worth while, section is still pretty short. Has no equations of its own.

Section 4 proofing complete, I added a picture of the Rotor I rode on with Karen. Not many equations.

Section 5 proofing is done, it iss very short, but I like it as a separate section to clarify the forest for the trees. No equations.

Section 6 I just did a little cleanup, proofing complete.

Section 7 went OK, lots of fine detail here, I doubt any other source has done anything like this. I am showing how to use the G Rule in very many examples here. Equation numbers all OK.

Section 8 proofing is done. I added the numbers for the earth on the frame part that is often neglected.

Signing off for this day, will continue proofing tomorrow. Need References and Introduction too.

8.6.12

Section 9 on Marion. Had to adjust a few things. This is a mere 1 page section, but it took a lot of work as I recall. I did not recheck the document references.

Section 10 proofing done. It is rather amazing that he is so different from Marion, but I think I have it nailed. Some day I might send a note to the GPS authors.

Section 11 proofing done, section is very short, it is needed to "fulfill the goal of Section 5". Note that I am checking all equation references in all my proofing.

Section 12 proofing done. Found a few bad equ nos and did some tunings. This is the summary section.

Section 13 proofing is underway. Am ready to start (e). Done now, this is a difficult section. I altered the ending a bit, adding the word symmetry. I don't care if my argument sells because the brute force method shows it is right.

Section 14 done. I decided to make Appendix A at the end to have more modularity and more reasonable equation numbers. It is much better that way.

Section 15 is now underway. (a) Somewhat painful, at least partitioned a bit into small pieces. Proofing complete. // All done. I added a piece on the high school frames of reference movies, very good. This is a tough section and I am sure it would be faster to use the polar coordinates in the right way, but I will leave it as is. These are examples of applying the equations I show. I did add an Exercise from my Paradox thing.

Big Error just discovered at 9:30 PM. Equation (15.32) and all that follows it is wrong because I have omitted the primes on x and y hat. I added them already to the previous 3 equations. So my 6 trajectories are going to be wrong as well.

8.7.12

Since I am now redoing Problem 2, and since it is based on the outputs of Problem 1, I am now carefully reviewing Problem 1 to avoid a huge error propagation.

Problem 2: // I have now heavily edited Ant's Motion in Frame S' opening section of Problem 2, and right there I convert to the $\hat{\mathbf{x}}$, $\hat{\mathbf{y}}$ expansions. That in itself was pretty interesting and took lots of work but the results are easy to interpret. // Trajectory edited, now starting the velocity section. // Velocity done, starting accel. // OK, at 2 PM I have all new plots, and I think Problem 2 proofing is complete. It was a long haul.

Problem 3: OK, it is proofed! Added bogus M&T plots.

8.8.12

Reference and intro are now complete. Now doing More proofing. **Section 1** in progress // and is now done. This really is an excellent section IMHO. It addresses topics I think people have always wondered about but have never read about.

Section 2 "read" easily and quickly, I think it is fine. **Section 3** is brief and I think makes the points I want it to make.

Section 4 underway. Part (c) is painful, but I don't really want to delete it. It is true that $\dot{b}_{S'}$ is most easily understood in the special cases. It never hurts I think to pick some object and try to interpret it. I admit this is a weak section and produces not much of use. The special cases are important to mention. But overall, I pronounce Section 4 as readable, not too long, and it maintains interest with some photos and the three scenarios, relieving the boredom induced by section (c).

Section 5 is instant! Since the reader is about to dive into the trees of the forest with many applications of the G Rule and many mysterious equations, I want to get the goal solidified beforehand.

Section 6 I reread fast, it is pretty well organized, the special cases are considered, it is OK.

Section 7 is pure workman (accels), but does comment on Coriolis 2 and how it arose.

OK, I have completed my pass through the entire document. I think.

Now is the time to look harder at "other peoples' documents" on the subject of rotating frames. // I browsed for an hour or so, finding many offerings but none really like mine. Only I would spend 85 pages exhuming all the fine formal details of this subject. Most sources get the acceleration equation, talk fictional forces, then do Coriolis and Foucault.

8.9.12

I reviewed Lai up to the point where he mentions the G Rule, then I started looking at my original Goldstein notes. Then I found the **Taylor** book and I see that he has quite a long chapter on my subject,. longest I have seen, and I am reading through it. Nice section on the tides. He uses I instead of we, something I have not seen before. He assumes a common origin for these two frames (I do not). Frames are called S (rotating frame) and S_0 (fixed frame), script font. He uses that Goldstein phrase that his S_0 frame is "fixed in the earth" (queasy feeling). Common origin is center of the earth. Rotating frame has basis vectors $\mathbf{e}_i$ and $\mathbf{Q} = Q_i\mathbf{e}_i$ expansion. His entire section 9.4 is to derive the G Rule! His name for it is "an important identity", p 342. My $\boldsymbol{\omega}$ is his $\boldsymbol{\Omega}$ and he assumes it is constant. He then gets the fictional forces equation. It is a good presentation, glad to have the book.

Did Coriolis use the G Rule in 1835?

""Sur les équations du mouvement relatif des systèmes de corps"

Read more of Crowe, altered my history note on the G Rule.

Got rid of my lousy section 4(c) about interpreting $\dot{\mathbf{b}}_{S'}$. My mess really just shows that you cannot interpret a cross velocity very well. I replaced it with some brief comments.

Did pagination. As usual, each section starts on a new page, and I made each of the three problems start on a new page as well. Pages are cheap. Did a full spell check, this doc is not too long for that.

I am finally ready to try to make a PDF. Doc is about 100 pages.

Pictures look crappy as usual unless blown up in Acrobat 4.

Overdots are not high enough in these equations:

(1.30), (1.32), (1.33) certain ones, (2.9), start of Section 8 too low on $\dot{\omega}$, all the $\dot{\omega}$ need raising.

Try the other viewer. Graphics much better, I should comment on that right in the pdf.

How do I globally raise dots? I want to open all field codes as usual (an option), then have to search, that was easy, about 120 replaced. Let's now do the same for single r dots, be careful!

Next, I want to unbold any bolded dots. It found 145, that went well. Found only two doubles bold.

PDF shows good dots, added link to the viewer. Now check paging. OK. Added comment on graphics right at the start. Thing is ready to fly.

Problem found: in Section 1 (a) heading, subscripts are bad. Since first heading, fix it! In fact I see this in many headings, so do that task tomorrow. Get it right please! Could it be since I edited them in the contents? Maybe make a test document for this.

August 16, 2012.

Many changes and additions have been made. Today I proofed/changed the **Overview** and the **Summary**. Then I did **Section 2** on the G Rule. Then short **Section 3**. Then **Section 4**. Then **Section 5**. **Section 6** is extremely "dry", but I checked everything on this pass. It is OK. **Section 7** is equally dry, I added a summary comment to this effect! Am checking every single thing in all these proofings. **Section 8** is very long. a,b,c done. OK, after a long time, Section 8 complete, now 7 PM. **Section 9** done, I added a little sentence on Taylor's notation. Done. **Section 10** done. **Section 11** done. **Section 12** done. **Section 13** done, found some horrible errors in the inverse equations, all fixed. **Section 14** is done. Section 15 which is very very long is done. **App A** done. **App B** done.

I have to completely repaginate everything.

Aug 18, 2012.

Adding Tensor G Rule Appendix C has caused revision of Section 1 (i), Section 2, so these need to be reproofed. I also need to get derivations of Section 1 (i) equations into repository.

Section 1 (i) proofed. **Section 2** proofed. **Appendix C** proofed, it is very good, a fitting finish for this long paper. Since App B got messed with recently, I will reread it now. **Appendix B** proofed.

Now another shot on the opening comments. **Overview** and **Summary** proofed!

Contents -- 2 pages
Overview -- 1 page
Summary -- 2 pages
Section 1 -- last page is 18
Section 2 -- 4 pages, fine.
Section 3 -- only 1 1/2 pages, fine.

Section 4 -- last page is 31
Section 5 -- 1/3 page!
Section 6 -- 3 pages exactly, good fit
Section 7 -- 4 pages, did one break adjust
Section 8 -- a monster section, last page is 64, all OK
Section 9 -- 1 1/3 pages, easy
Section 10 -- 2 1/2 pages, easy
Section 11 -- 1/2 page, easy
Section 12 -- summary is just one page, done.
Section 13 -- last page is 79. all OK, made pictures smaller for swap thing.
Section 14 -- 2 1/3 pages, easy.
Section 15 -- This is so long, I give and subsection its own page break start top reduce interactions for change I might make. DONE. I just added the coupled equations solution which I had wrong.
Appendix A -- short and done.
Appendix B -- 3 pages, good.
Appendix C -- done.

Pagination is now complete and it is 4 PM. Did a PDF, and I will now just visually scan for problems.

Errata:
p 103 an x hat missing prime
p 111 below 15.49 parens are screwed up
p 119 underbar too far application 3
p 119 space before In this (no extra space)

I will not fix these and make a new PDF at once. Oops

remove blue from the TOC. Must do this after every TOC update.

5:15 PM it is out there! I pushed both Bing and Google as well, see doc in web folder area.

Sept 11, 2012.

The new App D is installed, I just finished setting a good pagination. And then I did a full read-through with a few small edits, so this Appendix is ready to roll.

Overview: good.
Summary: good, tiny things fixed. Ends nicely on a page boundary.
Section 12 OK (swap and no swap stuff)
Section 13: needed pagination work, is now OK.
Section 1 review: something is wrong with (1.38). Equation 1 and 8 have the same LHS.
Section 2 review: all OK
Section 4 OK, skipped 3.

OK, enough. Tomorrow I will scan pagination only and then republish so I can move on.

Sept 12, 2012.

I did more pagination, added some stuff to the Marion Section comparing it to my swap notation which I think is helpful. Goldstein is so messy that I just skipped it. Did a final TOC and changed blue to black there and am now ready for a PDF with today's release date.

Oct 21, 2012

Today I will add section headers now that I know how to do it! DONE.
Did one errata.
Update the front matter.
Remake TOC and tune it.
Checked all bookmarks present in previous release.
Go for a cycle!

Oct 23-24. Decided to redo the L section, decoupling the two reference points. This causes a lot to change, but makes the comparison with Lai work right. ON Oct 24 using red I carefully verified the key results now called 11.3 and 11.4, then back to black. I have proofed sections (a), (b) and (c) with full accuracy checks. Decided to separate the fictitious force fluid dynamics into a new subsection.

Now I have to carefully update all my summary sections for my new L expressions.

• the **forward non-swap** equations will now be these:

$$\mathbf{F'}_{\mathtt{fict}} = -m\ddot{\mathbf{b}}_S - m\boldsymbol{\omega} \times (\boldsymbol{\omega} \times \mathbf{r'}) - 2m\,\boldsymbol{\omega} \times \mathbf{v'} - m\dot{\boldsymbol{\omega}} \times \mathbf{r'} \qquad (8.6)$$

frame centrifugal Coriolis Euler

For Special Case # 1 problems ($\boldsymbol{\omega}$ axis passes through Frame S origin), we have

$$\mathbf{F'}_{\mathtt{fict}} = -m\boldsymbol{\omega} \times (\boldsymbol{\omega} \times \mathbf{r}) - 2m\,\boldsymbol{\omega} \times \mathbf{v'} - m\dot{\boldsymbol{\omega}} \times \mathbf{r} \qquad \text{Special Case \#1} \qquad (8.12)$$

centrifugal Coriolis Euler

$$\mathbf{L}^{(c)} = \mathbf{L'}^{(c')} + (\mathbf{r'} - \mathbf{c} + \mathbf{b})\,(\boldsymbol{\omega} \times \mathbf{r'} + \dot{\mathbf{b}}_S) + (\mathbf{c'} - \mathbf{c} + \mathbf{b}) \times \mathbf{v'} \qquad (11.3)$$

$$\dot{\mathbf{L}}^{(c)} = \dot{\mathbf{L}}'^{(c')} + (\mathbf{c'} - \mathbf{c} + \mathbf{b}) \times \mathbf{a'} - \dot{\mathbf{c}}_S \times [\mathbf{v'} + \boldsymbol{\omega} \times \mathbf{r'} + \dot{\mathbf{b}}_S] + \dot{\mathbf{c}}'_{S'} \times \mathbf{v'}$$
$$+ (\mathbf{r'} - \mathbf{c} + \mathbf{b}) \times [\,\dot{\boldsymbol{\omega}} \times \mathbf{r'} + 2\,\boldsymbol{\omega} \times \mathbf{v'} + \boldsymbol{\omega} \times (\boldsymbol{\omega} \times \mathbf{r'}) + \ddot{\mathbf{b}}_S] \qquad (11.4)$$

and the fictitious forces will be these

$$\mathbf{N'}^{(c')}{}_{\mathtt{fict}} = -(\mathbf{c'} - \mathbf{c} + \mathbf{b}) \times m\mathbf{a'} + \dot{\mathbf{c}}_S \times [m\mathbf{v'} + m\boldsymbol{\omega} \times \mathbf{r'} + m\dot{\mathbf{b}}_S] - \dot{\mathbf{c}}'_{S'} \times m\mathbf{v'}$$
$$-(\mathbf{r'} - \mathbf{c} + \mathbf{b}) \times [\,m\dot{\boldsymbol{\omega}} \times \mathbf{r'} + 2m\boldsymbol{\omega} \times \mathbf{v'} + m\boldsymbol{\omega} \times (\boldsymbol{\omega} \times \mathbf{r'}) + m\ddot{\mathbf{b}}_S] \qquad (11.11)$$

where the second line is just $(\mathbf{r'} - \mathbf{c} + \mathbf{b}) \times \mathbf{F'}_{\mathtt{fict}}$ from (8.6).

• To get the forward *swap* equations, leave **b** and **ω** fixed, buy swap all primed with non-primed other things: (including c↔c')

$$\mathbf{F}_{\mathtt{fict}} = -m\ddot{\mathbf{b}}_{S'} - m\boldsymbol{\omega} \times (\boldsymbol{\omega} \times \mathbf{r}) - 2m\,\boldsymbol{\omega} \times \mathbf{v} - m\dot{\boldsymbol{\omega}} \times \mathbf{r} \qquad (8.6)_{\mathtt{s}}$$

frame centrifugal Coriolis Euler

For Special Case # 1 problems (**ω** axis passes through Frame S' origin), we have

$$\mathbf{F}_{\mathtt{fict}} = -m\boldsymbol{\omega} \times (\boldsymbol{\omega} \times \mathbf{r}') - 2m\,\boldsymbol{\omega} \times \mathbf{v} - m\dot{\boldsymbol{\omega}} \times \mathbf{r}' \qquad \text{Special Case \#1} \qquad (8.12)_{\mathtt{s}}$$

centrifugal Coriolis Euler

$$\mathbf{L}'^{(c')} = \mathbf{L}^{(c)} + (\mathbf{r} - \mathbf{c}' + \mathbf{b})\,(\boldsymbol{\omega} \times \mathbf{r} + \dot{\mathbf{b}}_{S'}) + (\mathbf{c} - \mathbf{c}' + \mathbf{b}) \times \mathbf{v} \qquad (11.3)_{\mathtt{s}}$$

$$\dot{\mathbf{L}}'^{(c')} = \dot{\mathbf{L}}^{(c)} + (\mathbf{c} - \mathbf{c}' + \mathbf{b}) \times \mathbf{a} - \dot{\mathbf{c}}'_{S'} \times [\mathbf{v} + \boldsymbol{\omega} \times \mathbf{r} + \dot{\mathbf{b}}_{S'}] + \dot{\mathbf{c}}_S \times \mathbf{v}$$
$$+ (\mathbf{r} - \mathbf{c}' + \mathbf{b}) \times [\,\dot{\boldsymbol{\omega}} \times \mathbf{r} + 2\,\boldsymbol{\omega} \times \mathbf{v} + \boldsymbol{\omega} \times (\boldsymbol{\omega} \times \mathbf{r}) + \ddot{\mathbf{b}}_{S'}] \qquad (11.4)_{\mathtt{s}}$$

$$\mathbf{N}^{(c)}{}_{\mathtt{fict}} = -(\mathbf{c} - \mathbf{c}' + \mathbf{b}) \times m\mathbf{a} + \dot{\mathbf{c}}'_{S'} \times [m\mathbf{v} + m\boldsymbol{\omega} \times \mathbf{r} + m\dot{\mathbf{b}}_{S'}] - \dot{\mathbf{c}}_S \times m\mathbf{v}$$
$$- (\mathbf{r} - \mathbf{c}' + \mathbf{b}) \times [\,m\dot{\boldsymbol{\omega}} \times \mathbf{r} + 2m\boldsymbol{\omega} \times \mathbf{v} + m\boldsymbol{\omega} \times (\boldsymbol{\omega} \times \mathbf{r}) + m\ddot{\mathbf{b}}_{S'}] \qquad (11.11)$$

where the second line is just $(\mathbf{r} - \mathbf{c}' + \mathbf{b}) \times \mathbf{F}_{\mathtt{fict}}$ from $(8.6)_{\mathtt{s}}$.

I have done them carefully in red, then back to black. Now we have the inverse problem summary to worry about:

The Inverse Problem. Here we don't show any fictional forces or torques because the frame on the left is inertial! We are just trying to get primed objects in terms of unprimed ones and we do this with these rules:

inverse non-swap = forward swap + negate b and ω

So here I will fix up the new L equations:

inverse non-swap L equations:

$$\mathbf{L}'^{(c')} = \mathbf{L}^{(c)} + (\mathbf{r} - \mathbf{c}' - \mathbf{b})\,(-\boldsymbol{\omega} \times \mathbf{r} - \dot{\mathbf{b}}_{S'}) + (\mathbf{c} - \mathbf{c}' - \mathbf{b}) \times \mathbf{v} \qquad (11.3)_{\mathtt{s}}$$

$$\dot{\mathbf{L}}'^{(c')} = \dot{\mathbf{L}}^{(c)} + (\mathbf{c} - \mathbf{c}' - \mathbf{b}) \times \mathbf{a} - \dot{\mathbf{c}}'_{S'} \times [\mathbf{v} - \boldsymbol{\omega} \times \mathbf{r} - \dot{\mathbf{b}}_{S'}] + \dot{\mathbf{c}}_S \times \mathbf{v}$$
$$+ (\mathbf{r} - \mathbf{c}' - \mathbf{b}) \times [\,-\dot{\boldsymbol{\omega}} \times \mathbf{r} - 2\,\boldsymbol{\omega} \times \mathbf{v} + \boldsymbol{\omega} \times (\boldsymbol{\omega} \times \mathbf{r}) - \ddot{\mathbf{b}}_{S'}] \qquad (11.4)_{\mathtt{s}}$$

inverse swap L equations:

$$\mathbf{L}^{(c)} = \mathbf{L}'^{(c')} + (\mathbf{r}' - \mathbf{c} - \mathbf{b})\,(-\boldsymbol{\omega} \times \mathbf{r}' - \dot{\mathbf{b}}_S) + (\mathbf{c}' - \mathbf{c} - \mathbf{b}) \times \mathbf{v}' \qquad (11.3)$$

$$\dot{\mathbf{L}}^{(c)} = \dot{\mathbf{L}}'^{(c')} + (\mathbf{c}' - \mathbf{c} - \mathbf{b}) \times \mathbf{a}' - \dot{\mathbf{c}}_S \times [\mathbf{v}' - \boldsymbol{\omega} \times \mathbf{r}' - \dot{\mathbf{b}}_S] + \dot{\mathbf{c}}'_S \times \mathbf{v}'$$
$$+ (\mathbf{r}' - \mathbf{c} - \mathbf{b}) \times [-\dot{\boldsymbol{\omega}} \times \mathbf{r}' - 2\,\boldsymbol{\omega} \times \mathbf{v}' + \boldsymbol{\omega} \times (\boldsymbol{\omega} \times \mathbf{r}') - \ddot{\mathbf{b}}_S] \qquad (11.4)$$

Made the red with edit, now back to black. Now install: DONE.

Preparation for Oct 24 release.

(1) remake TOC DONE
(2) check pagination of sections 1 starting with (h), Section 11, Section 12, Section 13 after (c), Refs. DONE
(3) remake TOC again, DONE
(4) clean up equation number positions using format copy where new equations done. DONE
(5) fix Lai reference, DONE
(6) update the Overview on Section 11, mention fluid and Reynolds.
(7) manual tune of the TOC DONE
(8) create a PDF
(9) quick scan of PDF looks OK.