The Math 401 Final Exam is in the format of: Choose your own Differential Adventure!

You are expected to TYPE up solutions to 4 problems with a connective theme which were not previously assigned for homework. Up to three of four of these problems may have book hints. You will then need to TYPE 2-4 paragraphs explaining your theme, highlighting the applicable concepts and theorems and how this connects with your choice of problems. Each problem needs to have a complete sentence to explain how it fits in. Your paragraphs can be interspersed throughout your write up.

Dates:
Proposal: due Wednesday 11/27 - Monday 12/2
Complete write up: due Monday 12/16 at 5pm
Location: Gradescope

Comments on your proposals will be available by Friday 12/6 at 5pm. You must fully type out the statement of each of the problems that you are picking and indicate from where they are in the book and if hints are given (or if they are external to the book, where you found them). You should write 3-4 sentences about your theme, namely, what is the theme, what are the names of the concepts you are using, and the statement of the main theorem(s) you are using. It is ok to paraphrase as long as the main concepts would be clear to another classmate. You may present the latter (concepts and theorems) as a list. You are welcome to come chat with me during office hours about your ideas for a theme and/or the problems you are thinking about picking out.

Grade Breakdown:
At the time of submitting your proposal and complete write up indicate:
75% on solutions 25% on write-up of connecting theme
85% on solutions 15% on write-up of connecting theme

Note that the higher % you place on the write-up of the connecting the theme, the more exposition you will need to give and this exposition will be expected to be of a higher quality. The higher % you place on the solutions, means that you will be expected to do slightly harder problems (e.g. at least 2 without hints). I would recommend selecting the 85% - 15% option. Moreover, if you do select problems with hints you will need to justify every step.

You do not need to write up the proof of the main theorems, though you are encouraged to indicate ideas if they are used in the solutions of your problems. Definitions do not have to go all the way back to basics, e.g. it would be ok to assume I know what the Gauss curvature is, but if you need to use k_1 and k_2 then you should probably tell me at some point that the Gauss curvature can be expressed in terms of their product.

If you get stuck on a problem you can replace it with a different problem during the write-up phase. You must seek approval from me if you want to swap out more than one problem.

Collaboration:
You are allowed to work with other students in the class on finding problems and themes. You may discuss solutions at a high level, e.g. indicating main concepts during the proposal stage. It is ok for you to have an "identical" problem list with other students. You should indicate the names of the students with whom you worked on the proposal. You are expected to write up the solutions

on your own and write up the theme on your own. The post proposal submission portion of this final project is pledged. If you use materials beyond the course book or notes, you'll need to get them okayed by me.

Sample themes:
Here are some ideas to get you started. Feel free to modify these as you see fit.

Applications to physics with the divergence theorem
Exercises 5.35 (Archimedes' principle), 5 (11) Laplacian, 6 (18) Laplacian, 6 (19), etc
Theme: Tell me your favorite application(s) of the divergence theorem in physics, and why the Laplacian is important. Teach me some physics! You can use your favorite physics textbook(s), provided you provide proper references.

Mean Curvature
Exercises 3 (2), 3(17), 3(18), 5(15), 6.14, 6.15, 6 (8), etc
Theme: Explain the evolution of tools to study mean curvature over the semester and/or your favorite things about Mean Curvature.

Integrals
Exercises 6 (9), 6.14, 6.15, 6 (20), etc
Theme: Explain why the divergence theorem is awesome (or sketch how these results are used to prove rigidity of ovaloids in §7.4).

Parallel Surfaces
Exercises 2 (9), 3 (16) - counts as two problems, 5 (9), 5 (15), 6 (2), etc
Theme: Explain how parallel surfaces are related to curvature and how they were used in the course to obtain interesting results in global extrinsic geometry.

Gauss Curvature
Exercises 3.40, 3.42, 3.51, 3 (19), 5.11, etc
Theme: Explain the evolution of tools to study mean curvature over the semester and/or your favorite things about Mean Curvature.

Connections between Gauss and Mean Curvature
Exercises 3.50, 6.14, 6.15, 6 (12), 6 (13), 6 (14), etc
Theme: Explain the evolution of tools to study the connections between Gauss and Mean Curvature.