To enable me to design 18.994 to meet your interests and needs, please answer the questions below and email me your responses. (My email is on the website.)

A. List the mathematics subjects (and relevant classes from Course 6, 8, etc.) you have taken at MIT or elsewhere, as well as similar background from independent study.

B. What has your favorite math course been? Why?

C. Do you have any prior experience reading scientific research papers?

D. What do you hope to gain from 18.994?
I’ll choose semester-start material based on your background knowledge and that of your classmates. To help me better understand your current knowledge of geometry, for each question below, please answer: 0 if you have no idea how to respond, 1 if you have some idea how to respond, 2 if you definitely know how to solve this problem/answer this question. This is not a quiz: your answers will not affect your grade, so please be honest.

1. Suppose $u : \mathbb{R}^3 \rightarrow \mathbb{R}$ is $C^\infty$ and has a global maximum at $(0, 0, 0)$. What can you say about the first and second derivatives of $u$ at $(0, 0, 0)$?

2. Suppose $u, v : \mathbb{R}^3 \rightarrow \mathbb{R}$ are $C^\infty$ and set $S := \{(x, y, z) \in \mathbb{R}^3 : v(x, y, z) = 0\}$. Suppose $u|_S$ has a local minimum at some point $(x_0, y_0, z_0) \in S$. What can you say about the derivatives of $u, v$ at $(x_0, y_0, z_0)$?

3. State some version of the implicit function theorem.

4. State some version of the divergence theorem.

5. Set $D := \{(x, y) \in \mathbb{R}^2 : x^2 + y^2 < 1\}$, and suppose $u \in C^\infty$ is compactly supported inside $D$. How can we integrate by parts to express the integral

$$\int_D u_x$$

as an integral over the unit circle, $\partial D$?


7. How do you measure the curvature of a plane curve?

8. How can you show that the shortest distance between two points in the plane is achieved by the straight line between these points?

9. Suppose you have a surface $S \subset \mathbb{R}^3$. How do you compute the length of a curve that is contained in $S$?

10. Set

$$S := \{(x, y, z) \in \mathbb{R}^3 : x^2 + y^2 + z^2 = 1\},$$

and $p := (1, 0, 0), q = (0, 0, 1)$. Describe a curve contained in $S$ that joins $p, q$, and has least length among all such curves. How many such length minimizing curves are there in $S$?

11. How do you compute the surface area of a surface in $\mathbb{R}^3$?

12. How can you describe the curvature of a surface in $\mathbb{R}^3$?