What is this course all about?

Welcome, class! Physics 105 is a course on classical mechanics, or, simply, mechanics. This course will be a physically strong and mathematically rich course that will be beneficial to your physics career forever. In particular, you should be quite open to learning and strengthening mathematical techniques, keeping in mind that they are inseparable from physics that we will discuss.

Should you need more motivation, read on.

Classical mechanics is, traditionally, the very first physics subject that you learn *in depth* after you wet your appetite in introductory courses.

The nature of physics courses is such that each course builds up on previous courses. Since classical mechanics is at the very bottom, it means it is immensely important to do well in classical mechanics. Without solid understanding of classical mechanics, you would find it very hard, if not impossible, to learn any other subject, e.g. quantum mechanics and relativity.

You may find that we are not doing anything new here, really, in terms of phenomena, in comparison to physics 5 (or equivalent). Then, what's new?

We become more professional here. Our language will become much more mathematically refined in this course so we can look deeper and farther. Mathematical techniques that you learned in 116 and we apply in this course will be your good friends forever, as they will be used again and again in physics problems beyond mechanics. Note that the mathematics that we will use here in this course *is* physics. All physics concepts and the mathematical techniques that clearly demonstrate those concepts, as we will learn in this course, are two sides of the same coin that is physics. They are inseparable. Therefore when we discuss mathematical techniques, make sure that physics guides you. That is the easy way, and, may I dare say, the *correct* way. All the mathematical techniques that we use in this course are real bread and butter in the business of physics, engineering and beyond. After you master this course, they should be always ready to go on top of your head, when and if you are to use your physics degree to make a living in any way.

Also, we will learn much deeper ways to view classical mechanics: Lagrangian formalism, Hamilton's principle and conservation principles. Aren't Newton's laws enough? Why are these new things necessary? The answer is that it never hurts to learn another point of view of the same thing. The more important reason is this, however. These new principles that we will learn permeate deep into all areas of physics, not just classical mechanics. In fact, not just physics, but also other disciplines such as economics. So in a way, they are more important than Newton's

laws.

Classical mechanics is a very ripe subject. What this means is that, albeit in a very narrow and strict sense, there has been nothing really new about this subject, since Newton showed how it is done in late 1600s. A kind of superman, really. What this definitely does not mean is that classical mechanics is useless to learn. It is immensely important for engineering, of course. Even for science, it is often that scientists find surprises and good uses of classical mechanics. Look at the new kind of science that sprang right from classical mechanics, namely non-linear dynamics and chaos theory, as recently as 40 years ago. Who knew that classical mechanics is still that fertile scientifically? Well, this question is silly . . . really. For any type of science subject, if you lift its thin veil of maturity with truthful and inquiring eyes, it is often the case that a genuine mystery and a chance for a discovery is waiting for you. Also, scientists have found that solving classical mechanics problems that correspond to a certain limit of some really difficult problems of quantum mechanics is very valuable, and so classical mechanics is very useful in this sense, in real research setting. Thus, classical mechanics continues to be an on-going research topic at the frontier in physics.

So, let us breathe deep and resolve to establish a very concrete foundation for your physics career here in this course. It will go a long way in helping you in your future endeavors. Last but not least, when you learn well and share your learning with others around you, you will for sure have fun doing it, so let us all do that – have a lot of fun.