PMU199H1S LEC0341 (April 2019) -- selected practice questions from old exams

The five questions on our final exam will each have two equally weighted parts. Here are some samples.

Q1: Particle Physics + Newton's Laws [20 marks]

- How did Ernest Rutherford uncover the structure of the atom? Draw a sketch to help illustrate.
- What are the four forces, and which particles are their messenger bosons?
- Why is the Higgs boson important to particle physics?
- Use Newton's laws of motion to explain why the Earth hardly moves when the professor jumps up and down during class.
- Describe the inverse square law for Newton's universal theory of gravitation.
- How can the ideas of recoil and redshift/blueshift help astronomers detect extrasolar planets?

Q2: Einstein's Refinements + GR and Black Holes [20 marks]

- What is the relationship between energy *E*, frequency f and wavelength λ for photons? Describe the electromagnetic spectrum.
- Describe the phenomenon of redshift/blueshift for photons. Give an example of a physics application.
- What is time dilation, and why was it a radical idea?
- Can a planet orbit around a black hole? Why or why not?
- How do black holes form? How can astronomers "see" them if they are black?
- Suppose that you threw a rock into a black hole. Why would it get spaghettified?

Q3: Quantum Mechanics [20 marks]

- Explain the phenomenon of spectral lines, i.e., why photons emitted by excited atoms have specific frequencies.
- What did Albert Einstein win the Nobel Prize for explaining?
- Is wi-fi radiation dangerous to your brain? Explain.
- What is diffraction? Why was the Davisson-Germer experiment important for quantum mechanics?
- Describe Young's double slit experiment showing wavelike properties of light. Include a sketch.
- What was it about Quantum Mechanics that got Albert Einstein upset?

Q4: Cosmology [20 marks]

- Why is the night sky not ablaze with starlight in all directions?
- How do we know that there was a Big Bang about 13.8 billion years ago?
- What did you enjoy learning the most about the Big Bang theory? (The physics, not the TV show.)
- Give a sketch of the pie chart of the energy budget of the universe.
- What is dark energy, and why is it important cosmologically?
- Explain the beautiful truth "we are starstuff".

Q5: Unification + String Theory [20 marks]

- What is spontaneous symmetry breaking? Give an example.
- What goes wrong if you try to put General Relativity together with Quantum Mechanics?
- How does string theory heal sicknesses of General Relativity at ultra-short distances?
- Could there be extra dimensions of space? Draw a sketch.
- What is the most interesting thing you learned about string theory?
- Explain how photons and gravitons are both naturally included in string theory.