The final examination be closed book and will consist of paraphrases of a subset of these questions. It will cover the lecture portions of the course with applications to the observatory experience. “Define” does not always mean, “give a formula for.” You may discuss these questions with me if any concepts are not clear.

1. Sketch the Ritter Observatory spectrograph system from the telescope to the data acquisition computer, Ceres, including all the components that interact with starlight or the information in the stellar spectrum.

2. What do the initials CCD stand for and what does this phrase mean in terms of operating principles of the device?

3. The CCD camera attached to the échelle spectrograph is cooled to 140 K (−133°C), but the CCD attached to the telescope (the ST-7) is cooled to only −10°C or so, even though the two CCDs themselves are similar. Why?

4. Define: gain of a CCD; quantum efficiency; readout noise; linearity; saturation

5. A particular property of photon counting allows the gain and the read noise to be determined from a pair of bias frames and a pair of flat frames. What is that property?

6. What is the function of the bias frames? The flat frames? The comp frames? Why do we take so many biases and flats?

7. Sketch the optical layout of a basic, single-grating spectrograph, and trace example light rays through it.

8. Sketch the optical layout of the échelle spectrograph. How does the échelle spectrograph break the spectrum up into strips and stack the strips one above the other?

9. In the échelle spectra, what is accurately aligned with the rows of the CCD? Why? What is tilted with respect to the columns of the CCD? Why?

10. If you examined repeated exposures of the flat lamp taken in succession, you would find that some features in the spectrum were the same in all the exposures while other features varied randomly. Which features? What is(are) the source(s) of the randomness? Does the answer to this question depend on the number of photons counted in each exposure?

11. What distinguishes an échelle grating from an ordinary grating like our cross-disperser?

12. Define: diffraction grating; blaze angle

13. Define: angular dispersion; linear dispersion; spectral resolution; resolving power; spectral purity; instrument function; solid angle; throughput
14. What determines how wide the entrance slit of a spectrograph should be? Discuss in terms of the desired data quality and in terms of the match to the detector.

15. The atmosphere in relation to astronomical observations: seeing; extinction; refraction

16. Optical fiber terminology: core, cladding; f/ratio degradation

17. What do you have to know or calculate in order to figure out whether a given star can be observed from Ritter in darkness on a given night (weather permitting)?