**Homework I BMES 421/621 Oct 18, 2023**

Please see the questions below and submit your answers to BBLearn as a Word-file (with equations included) or as a pdf of scanned handwritten solutions (needs to be clearly readable). It is recommended to review the “Modern Microscopies” paper to answer some of the questions.

1. What are the two types of optical aberrations noticed by the YouTubers (see posted video under week 2) for the Leica Noctilux 0.95? What do these aberrations cause to the quality of the image (in approx. 4 sentences)? **10**

2. What are the practical benefits for a user to be able to adjust the size of the pinhole in a confocal microscope? Describe each benefit with 2-3 sentences, name at least two benefits. **10**

3. How does the numerical aperture and magnification impact the brightness of fluorescence in a confocal microscope? Discuss/explain using an equation. **10**

4. For a wavelength of 500 nm and a numerical aperture of NA 1.0, what is the (lateral/xy) resolution of a fluorescence microscope? Compare to the (lateral) resolution of a confocal microscope. How much is it improved? Include applicable equations. **20**

5. What is the axial (z) resolution of a confocal microscope with a wavelength of 500 nm, NA 1.0? Provide the equation and solution. **20**

6a. You adjust a digital camera to a microscope. We assume a wavelength of 500 nm and a lens with an NA =1.0, what needs the sampling rate/pixel size of the sensor/CCD camera to be? (Remark: For simplicity we ignore the effect of magnification). **20**

6b. (**BMES 621 only)** You purchase a cell phone with a 61 megapixel (MP) camera, which has a CCD chip of 5.4 x 3.6 mm in size. You also know that the optics of this cellphone has an opening of f/2.0. Is this CCD too good (meaning too many pixels) for the resolution delivered by the optics (assume 500 nm green light)? Explain. Hint: you would need to determine (or look up) the pixel size for such a CCD chip. **10**

6c. **(BMES 421 only).** Show that your cell phone becomes “noisy” at low light levels. Document with an image taken under normal light conditions, and the same scene under low light. You can crop the images before you integrate them into your word/pdf file. **10**

Max points: 100