DAY 1 – 36 points (Open book, open notes, open internet!)

1. Consider a file nuclei.jpg - This file was imaged on a 12-bit CMOS camera at maximum illumination intensity, and saved as 8-bit.
   1. Can you analyze this image and accurately quantify the intensity of the nuclei? (2pt)
      1. Yes
      2. No
   2. Give a reason for your answer above in a short sentence  
      (~10 words or less, 4pts).
2. What is the maximum value allowed in an 8-bit signed-int image? (4pts)
   1. 255
   2. 256
   3. 127
   4. 128
   5. 65535
3. I have recorded a video sequence with 512 X 512 pixels, 16-bit depth, 10fps, for 30 seconds total duration. Answer the following questions about this video –  
   (2pt / 2pt / 2pt / 4pts)
   1. How many frames do I have in this video? Write your answer here.
   2. How many pixels do I have in each frame? Write your answer here.
   3. How many bytes are needed to store each pixel? Write your answer here.
   4. What is the minimum memory capacity I must have on my hard disk to store this video?
      1. 150 MB
      2. 157.3 MB
      3. 1.26 MB
      4. 1.26 GB
4. I wish to do an optical trapping experiment, where I have to measure the distance between two fluorescent beads, sized 50nm and spaced about 450nm apart.
   1. Should I use blue beads or red beads for my experiment? (2pt)  
      [Note – Wavelengths are about 350nm for blue light, and 700nm for red light.]
      1. Blue
      2. Red
   2. Explain your reason in 10 words or less. (4pts)
5. I have an 8-bit image with pixel values on a scale of 0-255. I wanted to enhance the contrast of this image, hence I squared each pixel. Later, I wanted to go back to the original image, so I took the square root of each pixel. Why would I fail to reconstruct the original image this way? (4pts)
   1. Squaring is not a linear operation, hence the image histogram got distorted
   2. Square roots can be positive or negative, hence my image went from unsigned to signed
   3. Some high pixel values likely got clipped when squaring, hence I lost data
   4. 8-bit images are not on a 0-255 scale, hence I gave misleading information in the question
6. I want to overlay the image of a heart (with 50% transparency) on top of an image of my cat (no transparency), to make a Valentine’s Day card for the feline of my heart. These are both 16-bit grayscale images. What “equation” best represents the mathematical operation I need to perform? Think it through carefully, all of the options are not actually identical in the context of images with finite bit-depth! (2pt)
   1. 0.5\*heart + 0.5\*cat
   2. (0.5\*heart + cat)/1.5
   3. 0.33\*heart + 0.67\*cat
   4. heart + 0.5\*cat
7. I took a picture of some sparse cells on a simple tissue culture microscope, with a DSLR camera. I suspect that the background intensity in the images is not uniform. What operation can I use to confirm my suspicions? (2pt)
   1. Down-sampling the image from 16-bit to 8-bit to reduce variations
   2. Profiling the background intensity along a line to see if it looks flat or not
   3. Changing the gamma value of the image to adjust contrast
   4. Applying a different LUT with uniform colour perception