Important: This is an open book test. You can use any books, notes, or paper, but not exchange anything with other students, or any other person via the internet. Change your cell phones to silent mode. If there is a syntax error in any program segment, just write it down and you will get full credit for the problem.

1. [8 pt] Suppose an image has 640 columns and 480 rows. It is stored in column-major order. Convert the coordinates (125, 17) and (317, 403) to 1D indices. Conversely, convert the 1D indices 17532 and 22902 to (x,y) coordinates.

2. [10 pt] Suppose the following 1D array of bytes in memory stores a 2×2 color image in BGR order: 164 33 43 84 145 151 117 204 60 22 192 217.

   (a) Assuming that the image is stored in interleaved format, convert to planar format. What are the RGB values of the pixel at location (1,1)?

   (b) Assuming that the image is stored in planar format, convert to interleaved format. What are the RGB values of the pixel at locatin (0,1)?

3. [6 pt] What type of vision is used to sense objects in sunlight, moonlight, and starlight?

4. [6 pt] What is the plenoptic function?

5. [10 pt] The probability distribution of pixel intensities in a 3-bit image is given as

0.33, 0.15, 0.05, 0.15, 0.07, 0.11, 0.09, 0.05

Create a lookup table to equalize this histogram.

6. [8 pt] Use 8-bit saturation arithmetic to compute the following:

(a) 52 + 200

(b) 86 + 199

(c) 30 - 50

(d) 32 + 11

7. [6 pt] Consider an image I. Applying histogram equalization to I yields the image I_h. If we apply histogram equalization to I_h, it yields I'_h. Is there a difference between I_h and I'_h? Explain why or why not.

8. [10 pt] Compute the variance of the following kernel:

$$1\ 2\ 3\ 4\ 5\ 4\ 3\ 2\ 1$$