Math 155, Spring, Vese

Final exam: Friday, March 15, time 1-2pm (during the last lecture).
(There will be no final exam during the week of finals.)

Sections covered for the final exam (3rd edition):
Chapter 4: Sections 4.2 (except 4.2.2), 4.4, 4.5 (except 4.5.4), 4.6, 4.7, 4.8, 4.9, 4.10, 4.11.
Chapter 5: Sections 5.1, 5.2, 5.3, 5.4, 5.5, 5.6, 5.7, 5.8, 5.9, 5.10, 5.11 (except 5.11.6).
Chapter 10: Sections 10.1, 10.2. (only parts that will be covered in class or in the Discussion Section). (this chapter may be left out at the last moment).

Sample theory questions (but not limited to this list):

• What is the definition of
- the arithmetic mean filter ?
- the geometric mean filter ?
- the harmonic mean filter ?
- the contraharmonic mean filter ?
- the median filter ?
- the max and mean filters ?
- the midpoint filter ?
- the alpha-trimmed mean filter ?

• Give the main steps of an adaptive, local noise reduction filter ? (explain).

• What is the goal of a bandreject filter for periodic noise reduction ? Give an example. What is the goal of a bandpass filter ? Give an example.

• Explain the optimum notch filtering technique.

• Questions about the definition and properties of the Fourier transform
- describe filtering in the frequency domain (give the main steps of filtering in the frequency domain)
- What is the convolution theorem ?
- give an example of a lowpass frequency filter
- give an example of a highpass frequency filter

• Give the definition of a unit impulse, located at coordinates (x_0, y_0).

• Show that, if $g(x, y) = H[f(x, y)]$, with H linear and position invariant, then H is given by a convolution with the function f.

• Show in continuous variables that the Fourier transform of

$$f(x,y)e^{2\pi i(u_0x+v_0y)}$$

is given by $F(u-u_0, v-v_0)$, where $F(u,v)$ is the Fourier transform of $f(x,y)$.

• Consider the motion degradation function

$$g(x,y) = \int_0^T f[x - x_0(t), y - y_0(t)]dt.$$

Find $H(u,v)$ such that $G(u,v) = H(u,v)F(u,v)$, where G and F are the Fourier transforms of g, f, respectively (show the details of the derivation).

• Give an example of a restoration filter (in the presence of blur)

• Recall the definition in continuous variables of the convolution

$$f(x,y) * g(x,y).$$

• Show that $\nabla^2(f*g) = f*(\nabla^2 g)$ at (x,y), where ∇^2 denotes the Laplace operator in (x,y).

The next topics are from Chapter 10, Section 10.2 (we will see how much we can cover before the final exam).

• Give an example of mask w that can be used to detect

- a light point on a constant dark background (explain)
- a light vertical line on a constant dark background (explain)

• Give the main steps of the zero-crossings of the Laplacian method for edge detection.

See additional problems and exercises from the homework and textbook.