Q.1 **a. What is SVD? Explain its usefulness in image processing.**

Answer:
The **SVD** is the optimal matrix decomposition in a least square sense that it packs the maximum signal energy into as few coefficients as possible. Singular value decomposition (SVD) is a stable and effective method to split the system into a set of linearly independent components, each of them bearing own energy contribution. Singular value decomposition (SVD) is a numerical technique used to diagonalize matrices in numerical analysis. SVD is an attractive algebraic transform for image processing, because of its endless advantages, such as maximum energy packing which is usually used in compression, ability to manipulate the image in base of two distinctive subspaces data and noise subspaces, which is usually uses in noise filtering and also was utilized in watermarking applications. Each of these applications exploits key properties of the SVD.

b. What are the effects of applying Butterworth low pass filter to the noisy image?

Answer:
When a **Butterworth low pass filter** is applied to a noisy image, there is smooth transition in blurring as a function of the amount of power removed from the spectrum. Moreover, no ringing is evident in the images processed with Butterworth low pass filter as the filter exhibits smooth transition between low and high frequencies.

c. How edge detection is used for detecting discontinuities in a digital image?

Answer:
Signals with very rapid evolutions such as transient signals in dynamic systems may undergo abrupt changes such as a jump, or a sharp change in the first or second derivative. Fourier analysis is usually not able to detect those events. The analysis by wavelets can detect the exact instant when a signal changes and also the type (a rupture of the signal, or an abrupt change in its first or second derivative) and amplitude of the change. In image processing, one of the major applications is edge detection, which also involves detecting abrupt changes.

d. Define pseudo inverse filtering with an example.

Answer: It is used in image restoration. For detail, see text book by Gonzalez.

f.   What do you mean by gray level slicing? Where it is applied?

Answer:
Grey level slicing is the spatial domain equivalent to band-pass filtering. A grey level slicing function can either emphasize a group of intensities and diminish all others or it can emphasize a group of grey levels and leave the rest alone. Applications include enhancing features such as masses of water, crop regions, or certain elevation area in satellite imagery.

g.   What is the principle of context based compression techniques?

Answer: Refer to the topic image compression in the text book by Gonzalez.

Q.2   a.   What are the sources of image degradation?

Answer: See digital Image Fundamentals in the text book by Gonzalez.

b. What is the use of Sobel filter? Draw the 3x3 Sobel mask.

Answer: Sobel Filtering:
Sobel filtering is a *three step* process. Two 3×3 filters (often called *kernels*) are applied separately and independently. The weights these kernels apply to pixels in the 3 × 3 region are depicted below:

-1	0	+1
-2	0	+2
-1	0	+1

+1	+2	+1
0	0	0
-1	-2	-1

Again, notice that in both cases, the sum of the weights is 0. The idea behind these two filters is to approximate the derivatives in x and y, respectively. Call the results of these two filters Dx(x, y) and Dy(x, y). Both Dx and Dy can have positive or negative values, so you need to add 0.5 so that a value of 0 corresponds to a middle gray in order to avoid clamping (to [0..1]) of these intermediate results.

The final step in the Sobel filter approximates the gradient magnitude based on the partial derivatives (Dx(x, y) and Dy(x, y)) from the previous steps. The gradient magnitude, which is the result of the Sobel Filter S(x, y), is simply:

$$S(x, y) = Sqrt((Dx(x, y))^2 + (Dy(x, y))^2)$$

For details see the text book by Gonzalez. (Intensity Transformation)

c.   What is role of point processing techniques in image enhancement? Explain one of the techniques used for point processing.

Answer: For details see the text book by Gonzalez (Intensity Transformation).

Q.3 **a.** **Explain how to generate a co-occurrence matrix.**

Answer: Page no 852 of Text Book.

b. **Explain Slant and Wavelet transforms in detail.**

Answer: See Intensity transformation and spatial filtering in the text book by Gonzalez.

c. **What is halftoning and dithering? How does it help in reducing visual artefacts?**

Answer: See Digital Image Fundamentals and spatial filtering in the text book by Gonzalez.

Q.4 **a.** **What is discontinuity in an image? How does Laplacian filter help in detecting such discontinuities?**

Answer: See Digital Image Fundamentals and spatial filtering in the text book by Gonzalez.

b. **What do you mean by shape-number of a boundary? Using a suitable example, describe various steps in the generation of a shape number.**

Answer: Page no 838-839 of Text Book.

Q.5 **a.** **Explain the erosion and dilation technique. Where are these techniques used and how they differ from each other?**

Answer: See morphological processing in the text book by Gonzalez

Q.6 **a.** **Explain the JPEG image data format. How does it achieve compression?**

Answer: See Image compression in the text book by Gonzalez.

Q.7 **Write short notes on the followings:**
(i) Image Filtering
(ii) Walsh Transform
(iii) Boundary following

Answer:
(i) See filtering in frequency domain in the text book by Gonzalez.
(ii) See Image Compression in the text book by Gonzalez.
(iii) Page no 818 of Text Book.

Text Book

Digital Image Processing by Gonzalez and Woods, Third Edition, Pearson Prentice Hall, low price edition, 2008.