

Max. Time: 1.5 Hrs

Max. Marks: 80

Q1. Select ALL the correct options from the choices or give very short answers.

1. A 2D convolution kernel is said to be isotropic if its response is independent of the directionality of patterns (edges) in the image. Which of the following are isotropic?
a. Laplacian b. Gaussian c. Sobel d. Sinc e. Any separable filter kernel
2. The Fourier Transform of an impulse train is:
a. Impulse train b. Sinc function c. Complex sinusoid d. None of the above
3. Given a band-limited function, any arbitrary spatial limited version will also be band-limited. True or False? Why?
4. Rotating an image by θ in spatial domain will cause its Fourier Transform to be:
a. Rotated by θ b. Rotated by $-\theta$ c. Remain the same d. None of the above

Q2. You are given two images with identical histograms. a) Does this mean that the images are identical? b) Prove or give a counter example for the following statement: Given that the histograms of two images are identical, the histograms of their low-pass (Gaussian) filtered versions will also be identical.

Q3. Describe the sampling theorem of a band-limited function and the conditions under which no information is lost by sampling. Explain the result in Fourier domain.

Q4. Derive the expression for the Fourier Transform of square pulse [8marks]. How can this be used to explain the ringing artifacts of an ideal low-pass filter? [2 marks]

**Q5. Explain how the DFT function can be expressed as a matrix multiplication. [8 marks]
What can this tell us about the DFT of the sum of two signals? [2 marks]**

Q6. The kernel of a high-pass filter has a bright spot (impulse) at the centre. Show why this is the case [8 marks]. Also show an example of the same [2 marks].

Q7. Using definitions of morphological operations, prove that: $(A \ominus B)^c = A^c \oplus \hat{B}$

Q8. Show the effect of closing the following image with a 3x3 box (all 1) structuring element. Foreground pixels are shown in dark in the image.

