

JK LAKSHMIPAT UNIVERSITY, JAIPUR

INSTITUTE OF ENGINEERING AND TECHNOLOGY

End Term Examination (Regular), November-December 2015

B. Tech in Computer Science Engineering, Semester VII

Subject Code: CSE 728

Roll No.....

Subject Name: Digital Image Processing

Time: 3 hours

Max. Marks: 100

Instructions to students:

1. Do not write anything other than your roll number on question paper.
2. Assume suitable data wherever required and mention it clearly.
3. Writing appropriate units, nomenclature, and drawing neat sketches/schematics/ flow chart wherever, required are an integral part of the answer.

Q.1A Objective type multiple choice questions (10 questions @ 1 mark)

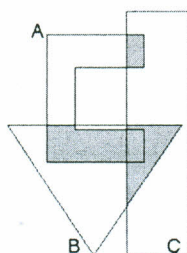
10

- i. Gamma rays have largest
(a) wavelength (b) frequency (c) energy (d) power
- ii. One that is not the measuring substance of the image is
(a) radiance (b) refraction (c) illumination (d) brightness
- iii. Functions that combines to produce image function $f(x,y)$
(a) illumination and frequency (b) intensity and reflectance
(c) illumination and radiance (d) illumination and reflectance
- iv. Thresholding function in contrast stretching creates
(a) binary image (b) high quality image
(c) enhanced image (d) low quality image
- v. The process of highlighting the specific range of intensities is called
(a) bit plane slicing (b) color slicing
(c) intensity level slicing (d) contrast stretching
- vi. Which of the following is the correct match of the following two lists of terms:
a. chessboard distance 1. bit plane slicing
b. power-law function 2. order-statistic filtering
c. intensity transformation 3. 8-neighbors
d. non-linear filtering 4. gamma correction
(a) a-3, b-4, c-2, d-1 (b) a-4, b-3, c-2, d-1 (c) a-3, b-4, c-1, d-2 (d) a-3, b-2, c-4, d-1
- vii. A 4-point sequence $\{f(0) f(1) f(2) f(3)\}$ is even if it has the form
(a) $\{a \ b \ c \ b\}$ (b) $\{0 \ -b \ 0 \ b\}$ (c) $\{a \ b \ b \ c\}$ (d) $\{b \ 0 \ -b \ 0\}$
- viii. If $F(u, v) = R(u, v) + jI(u, v)$, $j = \sqrt{-1}$, is the Fourier transform of a real function $f(x, y)$ [$R(u, v)$ and $I(u, v)$ are real and imaginary part of $F(u, v)$]. Which of the following is FALSE:
(a) $F(u, v)$ is conjugate symmetric (b) $R(u, v)$ is even, $I(u, v)$ is odd
(c) $R(u, v)$ is odd, $I(u, v)$ is even (d) if $f(x, y)$ is even then $F(u, v)$ is also even
- ix. Pseudo colors are also known as
(a) true colors (b) false colors (c) primary colors (d) secondary colors
- x. Full color image is a
(a) 20 bit image (b) 24 bit image (c) 28 bit image (d) 32 bit image

Q.2 Short answer type questions (4 questions @ 2.5 marks) 10

- Briefly illustrate the terms spatial resolution and intensity resolution.
- Consider a 1-D function f with a discrete unit impulse given as 0 0 0 1 0 0 0 0 and a filter w given as 1 4 6 4 7. Obtain the results of convolution of the filter w with the function f .
- Enlist the key steps for filtering an image in the frequency domain.
- Show that Fourier transform of an imaginary function $f(x, y)$ is conjugate asymmetric i.e. $F^*(u, v) = -F(-u, -v)$.

Q.3A i. Give expression for the sets shown shaded in the following figure in terms of sets A, B and C using the desired set operators. 02



- The median, ξ , of a set of numbers is such that half of the values in the set are below ξ and other half are above it. Show that an operator that computes the median of a subimage area, S , is nonlinear. 03

Q.3B i. How many minutes would it take to transmit a 512×512 image with 256 intensity levels at a rate of 64 Kbit/s? 02

- Consider the following arrangement of pixels and assume that p , p_2 , and p_4 have value 1 and that p_1 and p_3 can have a value of 0 or 1: 03

$$\begin{array}{cc} p_3 & p_4 \\ p_1 & p_2 \\ p & \end{array}$$

Suppose that we consider adjacency of pixels valued 1 (i.e., $V = \{1\}$). Considering all the possibilities for p_1 and p_3 , compute the D_m distances (the length of shortest m -path) between the p and p_4 .

Q.4A Briefly describe the following intensity transformations: 05

- Log transformation
- Bit-plane slicing

Q.4B Assuming continuous intensity values, suppose that an image has the intensity probability density function (PDF) given as 05

$$p_r(r) = \begin{cases} \frac{2r}{(L-1)^2}, & \text{for } 0 \leq r \leq L-1 \\ 0, & \text{otherwise} \end{cases}$$

Find the PDF $p_s(s)$ of the transformed (mapped) variable s . Prove mathematically and pictorially that $p_s(s)$ always is uniform i.e. *independently* of the form of $p_r(r)$.

Q.5A The following figure shows respectively a 3-bit image of size 5×5 image in the square, with x and y coordinates specified, Sobel operators and a weighted average filter.

	0	1	2	3	4
0	3	2	4	3	5
1	7	4	7	0	7
2	6	6	2	6	5
3	2	1	5	2	1
4	0	1	4	1	2

(a)

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

(b)

1	2	1
2	4	2
1	2	1

(c)

Determine the following:

- i. The output of the Sobel operators shown above at (2, 2). 02
 - ii. The output of the 3×3 weighted average filter shown above at (2, 2). 01
 - iii. The normalized histogram of the whole image. 02
- Q.5B Define first-order and second-order derivatives of a 1-D signal function $f(x)$. 05
- Consider a 1-D digital function which is representing a section of a horizontal intensity profile (scan line) from an image, given as
- | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 7 | 7 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 7 | 7 | 7 | 7 | 7 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
- i. Draw a plot for these intensities to demonstrate the idea of constant intensity, intensity transition, ramp and step.
 - ii. Draw a plot for values of first-order and second-order derivatives of the given 1-D function. Also point out the zero crossing in the plot.
- Q.6A If Fourier transform of 2-D discrete function $f(x, y)$ is $F(u, v)$ and Fourier transform of $h(x, y)$ is $H(u, v)$. Prove that the Fourier transform of $f(x, y) \star h(x, y)$ is $F(u, v)H(u, v)$, where " $\star$ " indicates the 2-D circular convolution. 05
- Q.6B If a continuous 1-D function $f(t)$ is sampled by using an impulse train $S_{\Delta T}(t)$ [with period ΔT] as the sampling function. The sampled function is obtained as $\tilde{f}(t) = f(t)S_{\Delta T}(t)$. Determine the Fourier transform $\tilde{F}(\mu)$ of the sampled function $\tilde{f}(t)$. Given the Fourier transform $S(\mu)$ of the sampling function $S_{\Delta T}(t)$ as $S(\mu) = \frac{1}{\Delta T} \sum_{n=-\infty}^{\infty} \delta\left(\mu - \frac{n}{\Delta T}\right)$. 05
- OR
- Q.6B Describe the aliasing effect caused by under-sampling a band limited function $F(\mu)$. How the aliasing effect can be reduced? 05
- Q.7A Prove that the 1-D discrete function $f(x) = \{f(0) \ f(1) \ f(2) \ f(3)\} = \{2 \ 1 \ 1 \ 1\}$ and its Fourier transform $F(u)$ are even. 05
- Q.7B If $1 \Leftrightarrow \delta(u, v)$ means the Discrete Fourier Transform (DFT) of 1 is a 2-D discrete impulse $\delta(u, v)$ in frequency domain and inverse discrete Fourier transform of $\delta(u, v)$ is 1. Using the translation property of 2-D DFT, show that the DFT of the discrete function $f(x, y) = \cos(2\pi u_0 x + 2\pi v_0 y)$ is $F(u, v) = \frac{j}{2} [\delta(u + Mu_0, v + Nv_0) + \delta(u - Mu_0, v - Nv_0)]$, where $j^2 = -1$ and $M \times N$ is the size of the function (image) $f(x, y)$. 05
- OR
- Q.7B Express the concept of unsharp masking and highboost filtering in frequency domain. Also extend the underlying concept to introduce the idea of high-frequency-emphasis filtering. 05

- Q.8A How image sharpening is performed in frequency domain? Explain the commonly used image sharpening filters in frequency domain. 10
- Q.9A Discuss the following color models with the desired mathematical relationships among them for converting one model into the other. 10
(i) RGB model (ii) CMY model (iii) HSI model
- Q.9B Discuss the following color image processing approaches with examples: 10
i. The technique of intensity (density) slicing
ii. Color image smoothing
- OR
- Q.9B Write short note on the following: (any two) 10
i. Application areas of DIP
ii. Image acquisition using sensor strips
iii. Full-color image processing
iv. Color slicing