

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.	Digital images are displayed as a discrete set of (a) values (b) numbers (c) frequencies (d) intensities	
ii.	Sensor strip is mounted in a ring configuration is used in (a) microscopy (b) medical (c) industry (d) radar	
iii.	Imaging system produces (a) high resolution image (b) voltage signal (c) digitized image (d) analog signal	
iv.	In bit plane slicing the most of the information of an image is contained by (a) highest order plane (b) lowest order plane (c) mid order plane (d) All planes	
v.	Method generating a processed image having specified histogram is called (a) histogram enhancement (b) histogram normalization (c) histogram equalization (d) histogram matching	
vi.	Which of the following is the correct match of the following two lists of terms: a. sampling theorem 1. aliasing b. image sharpening 2. Nyquist rate c. piecewise linear function 3. the Laplacian d. under sampling 4. intensity-level slicing (a) a-2, b-3, c-1, d-4 (b) a-4, b-3, c-2, d-1 (c) a-2, b-3, c-4, d-1 (d) a-2, b-4, c-3, d-1	
vii.	A 4-point sequence $\{f(0) f(1) f(2) f(3)\}$ is odd if it has the form (a) $\{0 -b 0 b\}$ (b) $\{a b b c\}$ (c) $\{b 0 -b 0\}$ (d) $\{a b c b\}$	
viii.	If $F(u, v) = R(u, v) + jI(u, v)$, $j = \sqrt{-1}$, is the Fourier transform of an imaginary 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 antisymmetric (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.	Color pixel is (a) scalar (b) coordinate (c) vector (d) Both (a) and (b)	
x.	Which of the following is FALSE w.r.t. $L^* a^* b^*$ color space? It is ----- (a) colorimetric (b) perceptually uniform (c) perceptually non-uniform (d) device independent	

Q.2	Short answer type questions (4 questions @ 2.5 marks)	10
i.	Represent the Weber ratio as a function of intensity through a plot and comment on brightness discrimination power of human visual system based on this plot.	
ii.	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 2 4 6 4 8. Obtain the results of correlation of the filter w with the function f .	
iii.	Briefly discuss the translation and rotation properties of the 2-D DFT.	
iv.	Show that Fourier transform of a real function $f(x, y)$ is conjugate symmetric i.e. $F^*(u, v) = F(-u, -v)$.	

Q.3A	Illustrate the process of digital image acquisition using array sensors.	05
Q.3B	Consider the image segment shown. Let $V=\{1, 2\}$ and compute the Euclidian, D_4 (City-block), D_8 (Chessboard) and D_m distance metrics between p and q .	05
	$ \begin{array}{cccc} & 3 & 1 & 2 & 1(q) \\ & 2 & 2 & 0 & 2 \\ & 1 & 2 & 1 & 1 \\ (p) & 1 & 0 & 1 & 2 \end{array} $	

Q.4A	Briefly describe the following intensity transformations:	05
i.	Power-law transformation	
ii.	Intensity-level slicing	
Q.4B	How do we implement first-order derivatives in image processing to perform nonlinear image sharpening? Give the mathematical expressions and corresponding masks for Roberts cross-gradient operators and Sobel operators.	05

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, a Laplacian filter, and a low-pass filter.	
------	---	--

$y \backslash x$	0	1	2	3	4		
0	3	7	6	2	0	Laplacian filter	Low pass filter
1	2	4	6	1	1	0 1 0	0.01 0.1 0.01
2	4	7	2	5	4	1 -4 1	0.10 0.56 0.10
3	3	0	6	2	1	0 1 0	0.01 0.1 0.01
4	5	7	5	1	2		

Determine the following:

i.	The output of the 3×3 median filter at (2, 2).	01
ii.	The output of the 3×3 Laplacian filter shown above at (2, 2).	01
iii.	The output of the 3×3 low pass filter shown above at (2, 2).	01
iv.	The normalized histogram of the whole image.	02
Q.5B	Consider the above shown 5×5 image as input image and determine the following:	
i.	The output 5×5 histogram equalized image.	03
ii.	The equalized histogram.	02

Q.6A	Find the Fourier transform, $F(\mu)$, of the function $f(t)$ defined as follows:	05
	$f(t) = \begin{cases} A, & \text{for } -W/2 \leq t \leq W/2 \\ 0, & \text{otherwise} \end{cases}$	
	Also show the plots of $F(\mu)$ and $ F(\mu) $ as a function of frequency μ .	
Q.6B	Show that the Fourier transform, $S(\mu)$, of an impulse train, $S_{\Delta T}(t)$, with period ΔT is also an impulse train, whose period is $1/\Delta T$.	05
	OR	
Q.6B	Why do we need to perform sampling? Use an impulse train $S_{\Delta T}(t)$ as the sampling function, describe the procedure (pictorially and mathematically) of obtaining the samples at uniform intervals ΔT for a continuous function $f(t)$.	05
Q.7A	Determine whether 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 or odd.	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 $f(x, y) = \sin(2\pi u_0 x + 2\pi v_0 y)$ 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	Explain the image enhancement (sharpening) using the Laplacian in the frequency domain.	05
Q.8A	How image smoothing is performed in frequency domain? Explain the commonly used image smoothing filters in frequency domain.	10
Q.9A	Explain the following pseudocolor image enhancement techniques:	10
	i. Intensity (density) slicing	
	ii. Intensity to color transformations	
Q.9B	In the context of color transformations, elaborate the following concepts:	10
	i. Mathematical model of color transformation	
	ii. Color complements	
	iii. Color slicing	
	OR	
Q.9B	Write short note on the following: (any two)	10
	i. Components of an image processing system	
	ii. Application areas of DIP	
	iii. CIE $L^* a^* b$ model	
	iv. Color image smoothing and sharpening	