

JK LAKSHMIPAT UNIVERSITY, JAIPUR

INSTITUTE OF ENGINEERING AND TECHNOLOGY

End Term Examination (Regular), November 2016
B. Tech in Computer Science Engineering, Semester VII

Subject Code: CSE728

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.	Digitization of spatial co-ordinates (x, y) is called (a) gray level quantization (b) finite sampling (c) image sampling (d) image quantization	
ii.	The storage requirement for a 512×512 binary image is ----- Kbits. (a) 512 (b) 256 (c) 128 (d) 1024	
iii.	A good image is difficult to define because image quality (a) high subjective, weakly dependent (b) lowly subjective, weakly dependent (c) high subjective, strongly dependent (d) lowly subjective, strongly dependent	
iv.	For coordinates $p(2,3)$, the 4 neighbors of pixel p are (a) $(3,3)(2,3)(1,3)(1,3)$ (b) $(3,3)(2,3)(1,1)(2,2)$ (c) $(3,3)(2,4)(1,3)(2,2)$ (d) $(3,3)(2,4)(1,3)(2,1)$	
v.	Which of the following is the correct match of the following two lists of terms: a. city block distance 1. aliasing b. power-law transformation 2. 4-neighbors c. piecewise linear function 3. gamma correction d. under sampling 4. intensity-level slicing (a) a-2, b-3, c-1, d-4 (b) a-2, b-3, c-4, d-1 (c) a-4, b-3, c-2, d-1 (d) a-2, b-4, c-3, d-1	
vi.	A 4-point sequence $\{f(0) f(1) f(2) f(3)\}$ is even if it has the form (a) $\{a \ b \ b \ c\}$ (b) $\{0 \ -b \ 0 \ b\}$ (c) $\{a \ b \ c \ b\}$ (d) $\{b \ 0 \ -b \ 0\}$	
vii.	If $f(t) \Leftrightarrow F(\mu)$ then which of the following is true: (a) $f(-t) \Leftrightarrow F(\mu)$ (b) $f(-t) \Leftrightarrow F(-\mu)$ (c) $F(t) \Leftrightarrow f(\mu)$ (d) $F(t) \Leftrightarrow f(-\mu)$	
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 asymmetric (b) $R(u, v)$ is odd, $I(u, v)$ is even (c) $R(u, v)$ is even, $I(u, v)$ is odd (d) if $f(x, y)$ is odd then $F(u, v)$ is real and odd	
ix.	Human perception of color closely resembles the _____ color model (a) CMY (b) RGB (c) HSI (d) CMYK	
x.	The total number of possible colors in a full-color image are ----- (a) 16777214 (b) 16777216 (c) 16777218 (d) 16777220	

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

10

- 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.
- Consider a 1-D function f given as $\{1\ 7\ 9\ 6\}$ and a filter w given as $\{1\ 3\ 5\}$. Obtain the result of convolution of the filter w with the function f .
- Consider the Gaussian function $w(x, y) = e^{-\frac{x^2+y^2}{2\sigma^2}}$, where σ is the standard deviation and coordinates x and y are integers. Assume $\sigma = 5$ and prepare a 3×3 filtering mask from the given function w .
- Determine the Fourier transform of the following 1-D continuous box function $f(t)$ given as $f(t) = \begin{cases} A, & \text{if } -\frac{W}{2} \leq t \leq \frac{W}{2} \\ 0, & \text{otherwise} \end{cases}$

Q.3A Explain the phenomenon brightness adaptation. Discuss various issues associated with human visual perception. 05

Q.3B Consider the image segment shown. Let $V=\{0, 1\}$ and compute the lengths of the shortest 4-, 8-, and m-path between p and q . If a particular path does not exist between these two points, explain why. 05

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      3  1  2  1(q)
      2  2  0  2
      1  2  1  1
      (p) 1  0  1  2
  
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Q.4A Briefly describe the following intensity transformations:

05

- Log transformation
- Intensity-level slicing

Q.4B 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:

- The output of the 3×3 median filter at $(2, 1)$.
- The output of the 3×3 Laplacian filter shown above at $(2, 1)$.
- The output of the 3×3 low pass filter shown above at $(2, 1)$.
- The normalized histogram of the whole image.

01
01
01
02

Q.5A	Assuming continuous intensity values, suppose that an image has the intensity probability density function (PDF) given as $p_r(r) = \begin{cases} \frac{2r}{(L-1)^2}, & \text{for } 0 \leq r \leq L-1 \\ 0, & \text{otherwise} \end{cases}$ 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. <i>independently</i> of the form of $p_r(r)$.	05
Q.5B	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.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 $\tilde{F}(\mu)$. Illustrate with example why do we require the sampling rate higher than twice the highest frequency for perfect recovery of the signal.	05
Q.7A	Consider the 1-D discrete function $f(x) = \{f(0) f(1) f(2) f(3)\} = \{1 \ 2 \ 3 \ 4\}$. Determine the Fourier transform $F(u)$ of $f(x)$ and prove that the real part of $F(u)$ i.e. $R(u)$ is even and its imaginary part i.e. $I(u)$ is odd.	05
Q.7B	If 1 and $\delta(u, v)$ constitute a Fourier transform pair i.e. $1 \Leftrightarrow \delta(u, v)$. 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 $F(u, v) = \frac{1}{2} [\delta(u + Mu_0, v + Nv_0) + \delta(u - Mu_0, v - Nv_0)],$ where $j^2 = -1$ and $M \times N$ is the size of the function (image) $f(x, y)$.	05
OR		
Q.7B	Give the frequency domain formulations for high-frequency-emphasis filtering technique of image sharpening. Also discuss its advantage over conventional highpass filters.	05
Q.8A	How image smoothing is performed in frequency domain? Explain the commonly used image smoothing 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. i. RGB model ii. CMY model iii. HSI model	10

Q.9B Explain the following pseudocolor image enhancement techniques: 10

- i. Intensity (density) slicing
- ii. Intensity to color transformations

OR

Q.9B Write short note on the following: (any two) 10

- i. Application areas of DIP
- ii. Image acquisition using sensor strips
- iii. CIE $L^* a^* b$ model
- iv. Color image smoothing and sharpening