CBCS SCHEME

USN | | | | | | | | | | |

17EC72

Seventh Semester B.E. Degree Examination, July/August 2021
Digital Image Processing

Time: 3 hrs. Max. Marks: 100

Note: ***Answer any FIVE full questions.***

1 a. Draw the block diagram of General Purpose image processing system and explain it. **(08 Marks)**

b. Explain the process of image sampling and quantization. **(08 Marks)**

c. Let p and q are pixels at co-ordinates (10, 12) and (15, 20) respectively. Find the which distance measure gives minimum distance between them. **(04 Marks)**

2 a. Discuss the relationship between pixels in details. **(08 Marks)**

b. Consider the image segment,

	3	1	2	① q
	2	2	0	2
	1	2	1	1
p	①	0	1	1

Let V = [0, 1], compute the length of 4, 8 and M path between p and q. If a particular path does not exist between p and q explain why? **(08 Marks)**

c. Mention the applications of image. **(04 Marks)**

3 a. Explain the following intensity transformation functions:
(i) Image negatives.
(ii) Log transformation.
(iii) Power law transformation. **(12 Marks)**

b. Explain Bit plane slicing with example. **(08 Marks)**

4 a. With the block diagram, and mathematical equations, explain Homomorphic filtering. **(10 Marks)**

b. Explain the Butterworth LPF and Gaussian LPF for image smoothing. **(10 Marks)**

5 a. Discuss the most commonly used noise probability density functions in image processing applications. **(10 Marks)**

b. Explain the following techniques used for noise removal in image processing:
(i) Arithmetic mean filter. (ii) Median filter **(10 Marks)**

6 a. Explain the followings for periodic noise reduction:
(i) Band rejection filters.
(ii) Band pass filters. **(10 Marks)**

b. Discuss the three principal way to estimate the degradation function for use in image restoration. **(10 Marks)**

7 a. Discuss the following color models:
(i) RGB color model.
(ii) CMY model.
(iii) HSI model **(15 Marks)**

b. Given RGB = (0.683, 0.1608, 0.1922) convert this to HSI model. **(05 Marks)**

8	a.	Draw the block diagram of pseudo color processing and explain it.	**(08 Marks)**
	b.	Explain two dimensional four band filter band for subband image coding.	**(08 Marks)**
	c.	What is duality of a morphological image processing?	**(04 Marks)**
9	a.	Explain the following of image segmentation: (i) Line detection (ii) Edge detection.	**(12 Marks)**
	b.	Explain region Splitting and Merging.	**(08 Marks)**
10	a.	Explain the chain codes used to represent a boundary.	**(08 Marks)**
	b.	Write the Otsu's algorithm used for optimum global thresholding.	**(08 Marks)**
	c.	What is skeletons?	**(04 Marks)**

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Signature of Scrutinizer

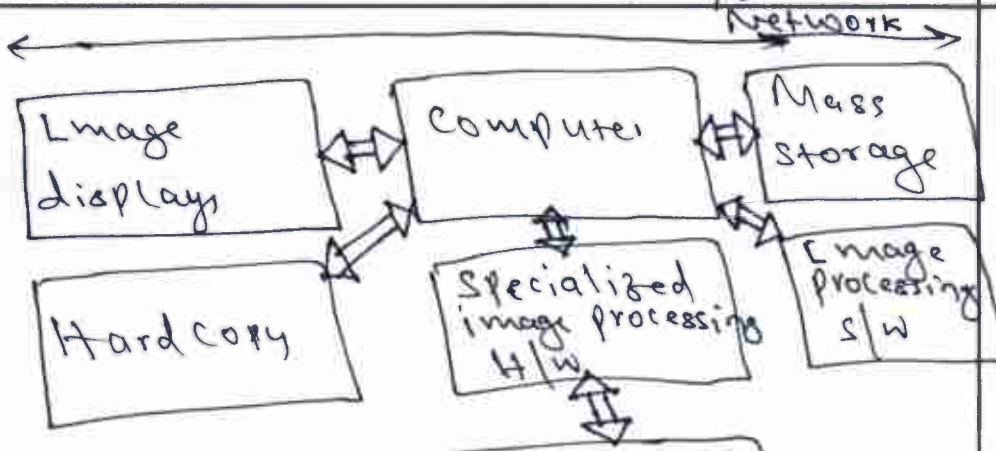
Scheme & Solutions

Subject Title : Digital image Processing **Subject Code :** 17EC72

Question Number	Solution	Marks Allocated

P-1/6

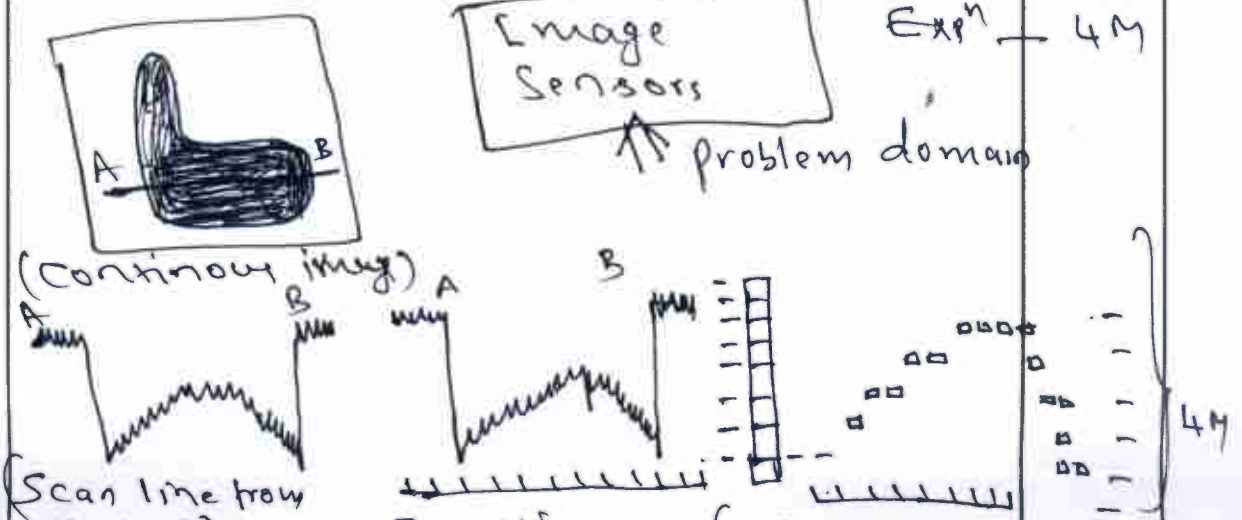
1 a)



4M

Expⁿ — 4M

b)



4M

Expⁿ — 4M

c) $(X, Y) = 10, 12$, $(S, t) = (15, 20)$

(i) Euclidean distance

$d_{eg}(P, Q) = \sqrt{(X-S)^2 + (Y-t)^2}$

$= \sqrt{89}$ — (1M)

(ii) D_4 distance:

$D_4(P, Q) = |X-S| + |Y-t|$

$= 13$ — (1M)

(iii) D_8 Distance

$D_8(P, Q) = \text{Max}(|X-S|, |Y-t|)$

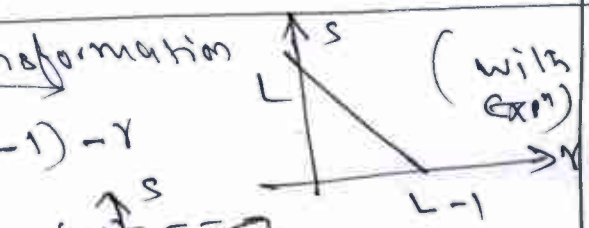
$= 8$ — (1M)

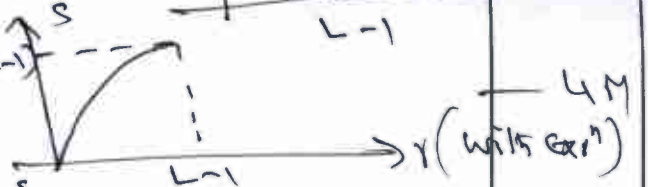
$D_8(P, Q) \rightarrow$ Minimum distance (1M)

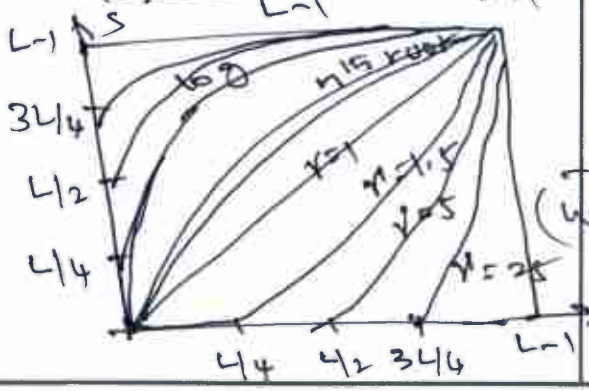
4M

Subject Title : Digital image processing Subject Code : 17EC72

Question Number	Solution	Marks Allocated
2 a)	Discuss:- Neighbours - Adjacency - Paths - Connectivity - Region - Boundary - Distance	8M
b)	(i) 4-adjacency (4 paths) → When V = {0, 1}, 4 paths does not exist ∴ It is impossible to connect p to q travelling along paths that are 4-adjacent	2M
	(ii) 8-adjacency (8-paths)	3M
	(iii) M-adjacency	3M
	3 1 2 1 2 2 0 2 1 2 1 1 1 → 0 1 1 Path length = 4	
	3 1 2 1 2 2 0 2 1 2 1 1 1 → 0 → 1 1 Path length = 5	
	3 1 2 1 2 2 0 2 1 2 1 1 1 → 0 → 1 1 Path length = 5	
c)	Applications	4M
3 a)	(i) Negative Transformation $S = T(r) = (L-1) - r$	(with Expn) 4M
	(ii) Log Trans $S = C \log(1+r)$	4M (with Expn)
	(iii) Power Law $S = C r^{\gamma}$	4M (with Expn)







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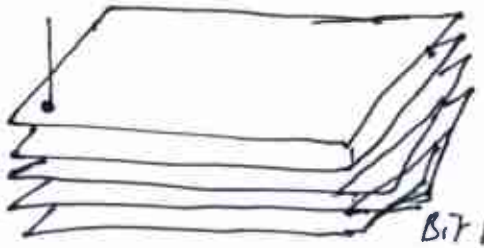
Question Number	Solution P-3/6	Marks Allocated

b)



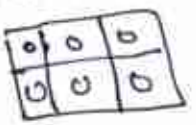
With Expn } — 5M

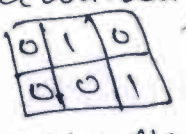
Ex:

6	7	8
4	2	5

(Any Example, mark can be awarded) } 3M

6 → 0 0 0 0 0 1 1 0
7 → 0 0 0 0 0 1 1 1
8 → 0 0 0 0 1 0 0 0
4 → 0 0 0 0 0 1 0 0
2 → 0 0 0 0 0 0 1 0
5 → 0 0 0 0 0 1 0 1


Bit-plane-7


Bit-Plane-0

4 a)

— 3M

$f(x,y) = i(x,y) \cdot r(x,y)$ — ①

$z(x,y) = \ln f(x,y) = \ln [i(x,y) \cdot r(x,y)]$ — ②

$F\{z(x,y)\} = F[\ln i(x,y) + \ln r(x,y)]$

$= F_i(u,v) + F_r(u,v)$ — ③

$S(u,v) = H(u,v)\, Z(u,v)$

$= H(u,v) F_i(u,v) + H(u,v) F_r(u,v)$ — ④

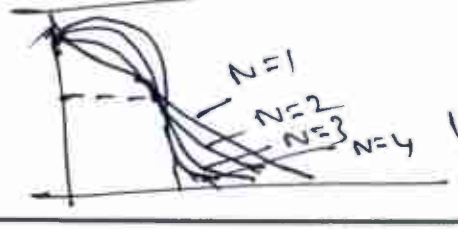
$s(x,y) = F^{-1}\{S(u,v)\}$

$= F^{-1}[H(u,v) F_i(u,v)] + F^{-1}[H(u,v) F_r(u,v)]$

$g(x,y) = e^{s(x,y)} = e^{F^{-1}[H(u,v) F_i(u,v)]} \cdot e^{F^{-1}[H(u,v) F_r(u,v)]}$

— 7M

b) i) Butterworth LPF;



$$H(u,v) = \frac{1}{1 + \left[\frac{D(u,v)}{D_0}\right]^{2N}}$$

where $D(u,v) = \left[\left(u - \frac{M}{2}\right)^2 + \left(v - \frac{N}{2}\right)^2\right]^{1/2}$

(With Expn) 5M

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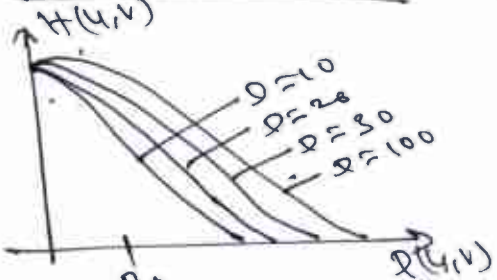
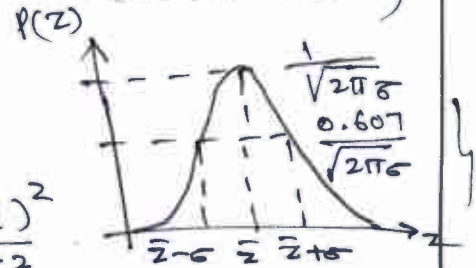
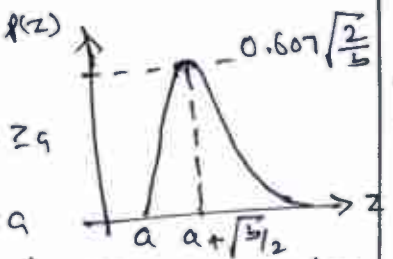
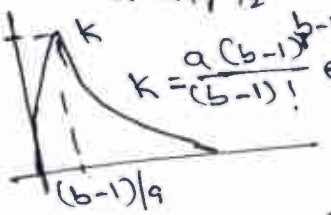
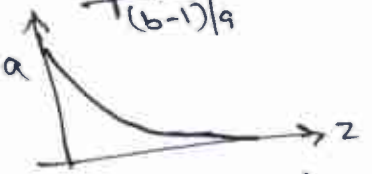
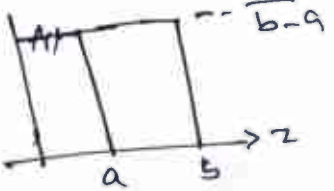
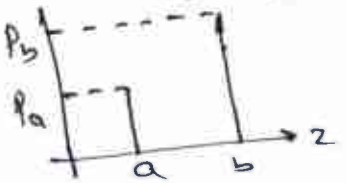
Question Number	Solution	Marks Allocated
	(i) Gaussian LPF $H(u,v) = e^{-D^2(u,v)/2\sigma^2}$ $= e^{-D^2(u,v)/2D_0^2}$ (with Expn) 	5M
5 a)	(i) Gaussian Noise: $p(z) = \frac{1}{\sqrt{2\pi}\sigma} e^{-\frac{(z-\bar{z})^2}{2\sigma^2}}$ 	2M
	(ii) Rayleigh noise: $p(z) = \begin{cases} \frac{2}{b}(z-a)e^{-(z-a)^2/b} & \text{for } z \geq a \\ 0 & \text{for } z < a \end{cases}$ 	2M
	(iii) Erlang (gamma) noise: $p(z) = \begin{cases} \frac{a^b z^{b-1}}{(b-1)!} e^{-az}, & \text{for } z \geq 0 \\ 0, & \text{for } z < 0 \end{cases}$ 	2M
	(iv) Exponential Noise: $p(z) = \begin{cases} a e^{-az}, & \text{for } z \geq 0 \\ 0 & \text{for } z < 0 \end{cases}$ 	2M
	(v) Uniform Noise: $p(z) = \begin{cases} \frac{1}{b-a}, & \text{if } a \leq z \leq b \\ 0, & \text{otherwise} \end{cases}$ 	2M
	(vi) Impulse noise $p(z) = \begin{cases} P_a & \text{for } z = a \\ P_b & \text{for } z = b \\ 0 & \text{otherwise} \end{cases}$ 	2M 10M
5)	Arithmetic Mean filter (Expn)	5M
	Median filter (Expn)	5M
6 a)	Band rejection filter (Expn)	5M
	Band pass filter (Expn)	5M

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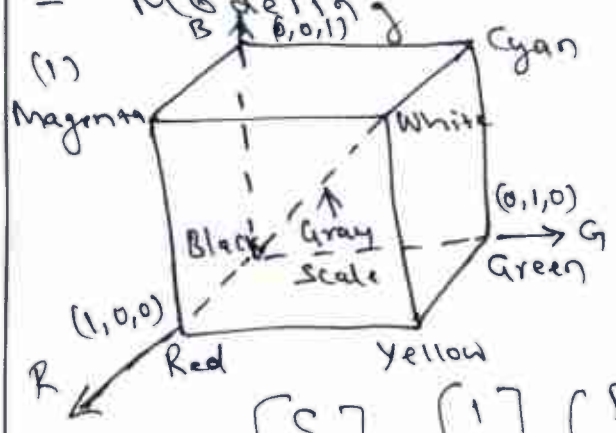
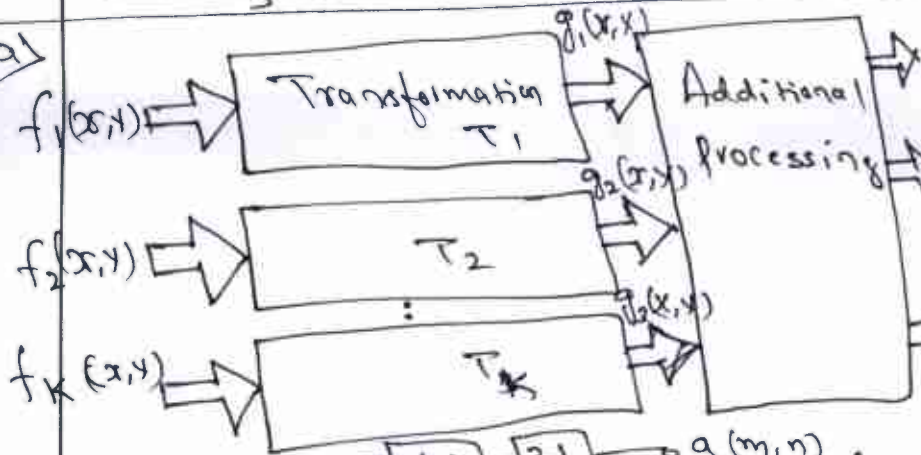
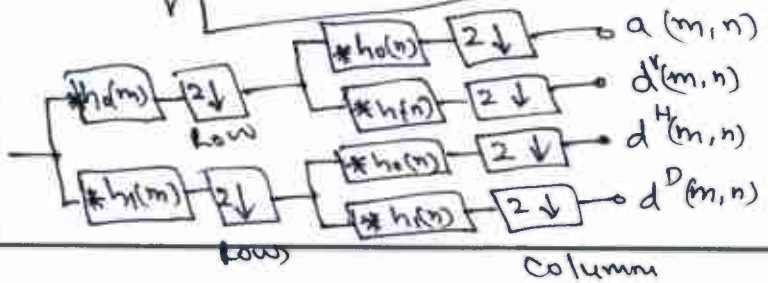
Question Number	Solution	Marks Allocated
6 a)	Three Methods of Estimating the Degradation function are - Image observation -(4M) - Experimentation (3M) - Modeling (3M)	4+3+3 = 10M (with Expn)
7 a)	(i) 	2M Expn – 3M
	(ii) CMY : $\begin{bmatrix} C \\ M \\ Y \end{bmatrix} = \begin{bmatrix} 1 \\ 1 \\ 1 \end{bmatrix} - \begin{bmatrix} R \\ G \\ B \end{bmatrix}$	1M Expn – 4M
	(iii) HSI :	5M
b)	$\theta = \cos^{-1}\left[\frac{\frac{1}{2}[(R-G)+(R-B)]}{[(R-G)^2+(R-B)(G-B)]^{\frac{1}{2}}}\right] = 3.010$	2M
	$H = 360 - \theta$ ($\because B > G$) $= 356.99$	1M
	$S = 1 - \frac{3}{R+G+B}\min(R,G,B) = 0.534$	1M
	$I = \frac{1}{3}(R+G+B) = 0.3453$	1M
8 a)		4M Expn – 4M
b)		3M Expn – 5M

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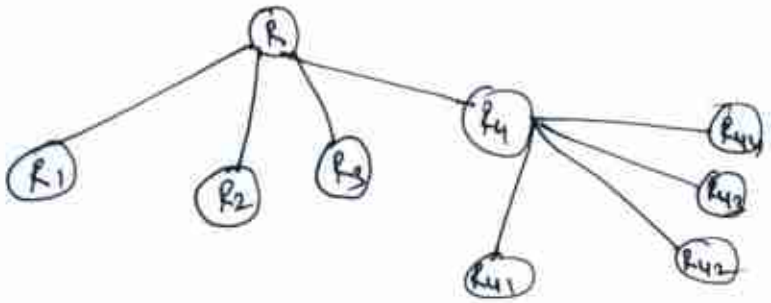
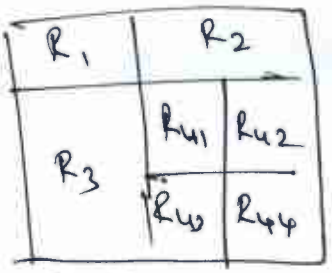
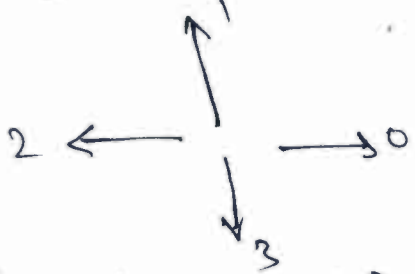
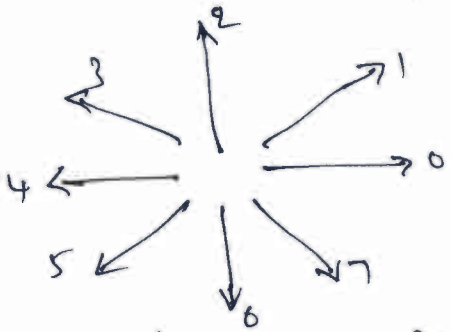
Q. No	Solution P-6/6	Marks allocated
8 c)	$A \oplus B = \{ z \mid (\hat{B})_z \cap A \neq \emptyset \}$ → based on reflecting B about its origin and shifting $A \oplus B = \{ z \mid [(\hat{B})_z \cap A] \subseteq A \}$ with Expn	4M
9 a)	Explanation of line Detection ———	6M
	—— " —— Edge Detection ———	6M
b)	  	-3M
10 a)	Used to represent a boundary by a connected Seq. of straight line segments of specific lengths & direction  (4-directional)  (8-directional)	— 3M Expn — 5M
5 b)	① Compute the normalized histogram of the input image	
10 b)	② Compute the Cumulative Sums, $P_1(K)$	
	③ ——— " ——— " ——— means, $m(K)$	
	④ Compute the global intensity mean m_G	
	⑤ Compute the between class variance $\sigma_B^2(K)$	
	⑥ obtain the Otsu threshold, K^*, as the value of K for which $\sigma_B^2(K)$ is Maximum	
	⑦ obtain the Separability measure, η^*, by evaluating at $K = K^*$ ———	4M
c)	Skeleton's (with Expn)	