Roll No													

PRESIDENCY UNIVERSITY
BENGALURU

SCHOOL OF ENGINEERING

TEST 1

Seme & AY: Odd Sem. 2019-20

Course Code: ECE 307

Course Name: DIGITAL IMAGE PROCESSING

Program & Sem: B.Tech (ECE) & V DE

Date: 27.09.2019

Time: 2.30PM to 3.30PM

Max Marks: 40

Weightage: 20%

Instruction:

(i) Read the question properly and answer accordingly.

(ii) Question paper consists of 3 parts.

(iii) Scientific and Non-programmable calculators are permitted.

Part A [Memory Recall Questions]

Answer all the Questions. Each Question carries one marks. (10Qx1M=10M)

1. If R is a subset of pixels, we call R a _____ of the image if R is a connected set.

(C.O.NO.1) [Knowledge]

(a) Disjoint (b) Region (c) Closed (d) Adjacent

2. The distance between pixels p and q, the pixels have a distance less than or equal to some value of radius r, form a diamond centred at (x,y) is called :

(C.O.NO.1) [Knowledge]

(a) Euclidean distance (b) Chessboard distance

(c) City-Block distance (d) None of the Mentioned

3. A pixel "p"at coordinates (x, y) has neighbors whose coordinates are given by: (x+1, y+1), (x+1, y-1), (x-1, y+1), (x-1, y-1) .This set of pixels is called _____

(C.O.NO.1) [Knowledge]

(a) 4-neighbors of p (b) Diagonal neighbors

(c) 8-neighbors (d) None of the mentioned

4. In terms of Sampling and Quantization, Zooming and Shrinking may be viewed as __

(C.O.NO.1) [Knowledge]

(a) Oversampling for both

(b) Undersampling for both

(c) Undersampling & Oversampling respectively

(d) Oversampling & Undersampling respectively

5. After digitization process a digital image with M rows and N columns have to be positive and for the number, L, max gray levels i.e. an integer power of 2 for each pixel. Then, the number b, of bits required to store a digitized image is: (C.O.NO.1) [Knowledge]

(a) b=M*N*k (b) b=M*N*L (c) b=M*L*k (d) b=L*N*k

6. Which is a colour attribute that describes a pure colour? (C.O.NO.1) [Knowledge]

(a) Saturation (b) Hue (c) Brightness (d) Intensity

7. To convert a continuous image f(x, y) to digital form, we have to sample the function in _ (C.O.NO.1) [Knowledge]

(a) Coordinates (b) Amplitude` (c) All of the mentioned
(d) None of the mentioned

8. How many number of steps are involved in image processing? (C.O.NO.1) [Knowledge]

(a) 12 (b) 9 (c) 11 (d) 10

9. While implementing logic operation on gray-scale images, the processing of pixel values is done as _____ (C.O.NO.1) [Knowledge]

(a) String of integer numbers (b) String of floating numbers
(c) String of binary numbers (d) None of the mentioned

10. Which of the following is more commercially successful image enhancement method in mask mode radiography, an area under medical imaging? (C.O.NO.1) [Knowledge]

(a) Addition (b) Subtraction (c) Multiplication (d) Division

Part B [Thought Provoking Questions]

Answer all the Questions. Each Question carries five marks. (3Qx5M=15M)

11. Define the following: (C.O.NO.1) [Knowledge]

(i) Image Transformation (ii) Unitary Matrix
(iii) Orthogonal basis function (iv) Orthonormal basis function

12. Discuss the relationship between Neighbors of pixels P(x,y): (C.O.NO.1) [Comprehension]

(i) $N_4(P)$ (ii) $N_D(P)$ (iii) $N_8(P)$

?	?	?
?	P(x,y)	?
?	?	?

13. Discuss 4-adjacency, 8-adjacency and m-adjacency. (C.O.NO.1) [Comprehension]

Part C [Problem Solving Questions]

Answer all the Questions. Each Question carries five marks. **(3Qx5M=15M)**

14. An image segment F1 and F2 are given : $F1=\begin{matrix}1&0&1\\1&1&1\\0&1&0\end{matrix}$ and $F2=\begin{matrix}1&1&1\\1&1&0\\0&0&1\end{matrix}$, perform

(i) X1 = NOT F1 (ii) X2 = F1 AND F2 (iii) X3 = F1 OR F2 (iv) X4 = F1 XOR F2
(v) X5= F1 AND NOT(F2)

(C.O.NO.1)[Comprehension]

15. (a) Calculate the number of bits required to store a binary image, a gray image and color image of size 1024 X 1024
(b) Compute Eculidean distance (De) for points P(3,2,3) and Q(2,3,7).

(C.O.NO.1) [Comprehension]

16. An image segment A1 and A2 are given : $A1=\begin{matrix}7&11&30\\24&8&15\\18&14&10\end{matrix}$ and $A2=\begin{matrix}4&6&8\\1&3&7\\9&2&5\end{matrix}$, perform array operations such as addition, subtraction and multiplication.

(C.O.NO.1) [Comprehension]

PRESIDENCY UNIVERSITY
BENGALURU

SCHOOL OF ENGINEERING

TEST – 1

Semester: V
Course Code: ECE307
Course Name: Digital Image Processing
Program & Sem: B.Tech/ ECE/ 5th Sem

Date: 27-09-2019 (Friday)
Time: 2.30 PM to 3.30 PM
Max Marks: 40
Weightage: 20%

Extract of question distribution [outcome wise & level wise]

Q.NO.	C.O.NO	Unit/Module Number/Unit /Module Title	Memory recall type [Marks allotted] Bloom's Levels	Thought provoking type [Marks allotted] Bloom's Levels	Problem Solving type [Marks allotted]	Total Marks
			K	C	A	
1 to 10	1	Module1	1x10			10 marks
11	1	Module2	5			5 marks
12	1	Module1		5		5 marks
13	1	Module1		5		5 marks
14	1	Module1		5		5 marks
15	1	Module1		5		5 marks
16	1	Module1		5		5 marks
	Total Marks		15	25		40 marks

K =Knowledge Level C = Comprehension Level, A = Application Level
Note: While setting all types of questions the general guideline is that about 60% Of the questions must be such that even a below average students must be able to attempt, About 20% of the questions must be such that only above average students must be able to attempt and finally 20% of the questions must be such that only the bright students must be able to attempt.

23/09/19

I here certify that All the questions are set as per the above lines Natya S]

Re-Check Q11, Q12

PRESIDENCY UNIVERSITY
BENGALURU

SCHOOL OF ENGINEERING

TEST – 1

Semester: V
Course Code: ECE307
Course Name: Digital Image Processing
Program & Sem: B.Tech/ ECE/ 5th Sem

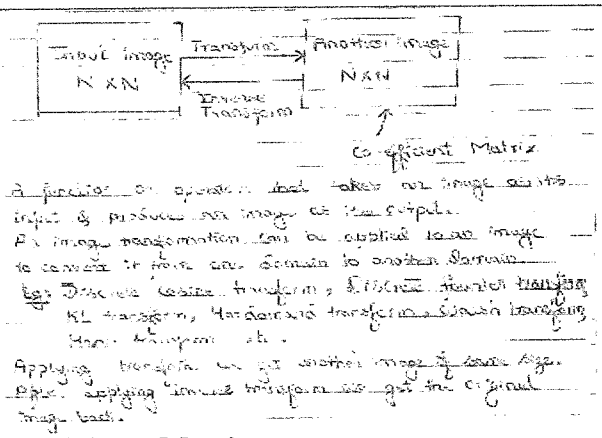
Date: 27-09-2019 (Friday)
Time: 2.30 PM to 3.30 PM
Max Marks: 40
Weightage: 20%

Part A **(10Q x 1M = 10Marks)**

Q. No.	Solution	Scheme of Marking	Max. Time required for each Question
1.	(b) Region	1	1min
2.	(c) City-Block distance	1	1min
3.	(b) Diagonal neighbors	1	1min
4.	(d) Oversampling & Undersampling respectively	1	1min
5.	(a) b=M*N*k	1	1min
6.	(b) Hue	1	1min
7.	(a) Coordinates	1	1min
8.	(d) 10	1	1min
9.	(c) String of binary numbers	1	1min
10.	(b) Subtraction	1	1min

Part B **(3Q x 5M = 15Marks)**

Q. No	Solution	Scheme of Marking	Max. Time required for each Question
11.	**(i) Image Transformation**	2+1+2=5M	10 Min



(ii) Unitary Matrix

A matrix "A" is said to be a unitary matrix if inverse of A is equal to A star transpose where A star is the complex conjugate of A.

$$A^{-1}=A^{*T}$$

(iii) Orthogonal basis function and

(iv) Orthonormal basis function

For 1-D signal :

Consider a set of real valued continuous functions is said to be orthogonal over an interval T if

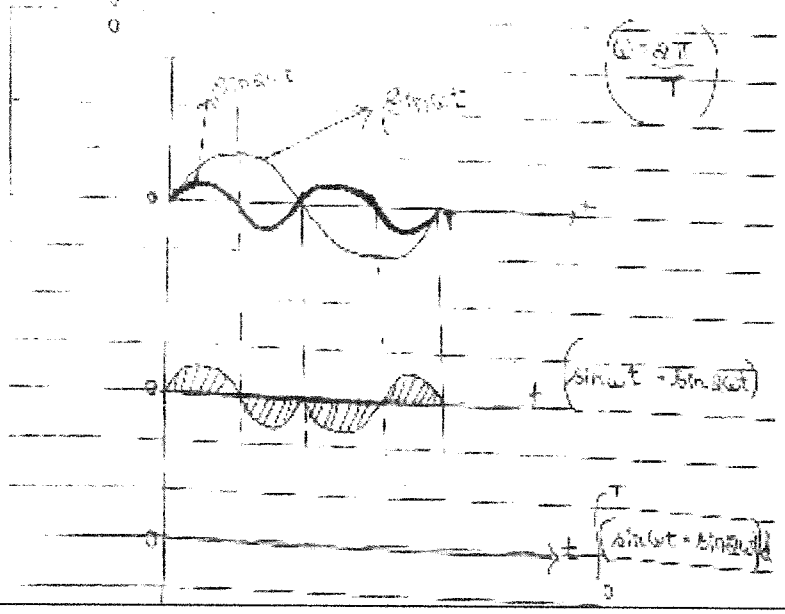
$$\int_0^T \phi_m(t)\,\phi_n(t)\,dt = \begin{cases} K & m = n \\ 0 & m \neq n \end{cases}$$

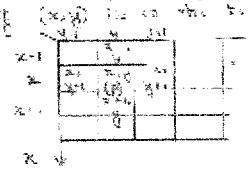
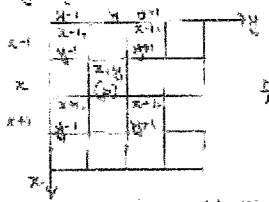
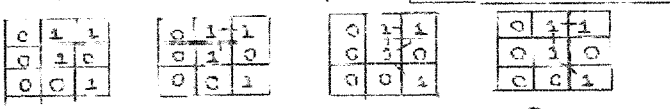
Where $\{\phi_n(t), n = 1, 2, \ldots\}$

If the value of K is equal to 1 then the set is orthonormal.

Eg: $\{\sin t, \sin 2t, \sin 3t, \ldots\}$ over an interval $t = 0$ to π.

$$\int_0^{2\pi} \sin nt \cdot \sin mt\,dt = 0$$



12.	Neighbours of a pixel: A pixel 'p' at co-ordinates (x,y) has 2 horizontal & 2 vertical neighbours with co-ordinates $(x+1,y), (x-1,y), (x,y+1), (x,y-1)$ The above set of pixels are called as the 4-neighbours of a pixel 'p' denoted by $N_4(p)$. Some of the neighbours of a pixel 'p' lie outside the digital image if (x,y) lie on the borders of the image.  Fig: 4-neighbours of pixel 'p' $N_4(p)$ A pixel 'p' at co-ordinates (x,y) has 4 diagonal neighbours having co-ordinates $(x+1,y+1), (x+1,y-1), (x-1,y+1), (x-1,y-1)$ The diagonal neighbours are denoted by $N_D(p)$. Some of the pixels in $N_D(p)$ and $N_8(p)$ may also lie outside the digital image if (x,y) lie on the borders of the image.  Fig: 4-diagonals of pixel 'p' $N_8(p)$ 4-neighbours & 4-diagonal-neighbours are together called as 8-neighbours of a pixel 'p' denoted by $N_8(p)$.	2+2+1=5M	10 Min
13.	② Adjacency, Connectivity, Regions & Boundaries: ① Let V be a set of gray-level values (intensity values) used for defining adjacency Eg: $V=\{1\}$ if we are referring to adjacency of pixels with value 1 in a binary image. (binary image has only 2 gray levels 0 & 1). In a gray scale image set V can have a number of possible values 0-255 i.e. 256 gray levels are there. ② There are 3 types of adjacency (a) 4 - Adjacency (b) 8 - Adjacency (c) m - Adjacency (mixed Adjacency) (a) 4 - Adjacency: Two pixels p & q with values from V are 4-adjacent if q is in the set $N_4(p)$. $[p,q \in V \ \& \ q \in N_4(p)]$ (b) 8 - Adjacency: Two pixels p & q with values from V are 8-adjacent if q is in the set $N_8(p)$. $[p,q \in V \ \& \ q \in N_8(p)]$ (c) m - Adjacency (Eliminates multiple path connections that will be generated by 8-adjacency) Two pixels p & q with values from V are m-adjacent if (i) q is in $N_4(p)$ (or) (ii) q is in $N_8(p)$ & the set $N_4(p) \cap N_4(q)$ has no pixels whose values are from V. $[q \in N_4(p) \ \& \ N_4(p) \cap N_4(q) = \phi]$  (a) Arrangement of pixels (b) 4-adjacency (c) 8-adjacency (d) M-adjacency $V=\{1\}$	1+1+1+2=5M	10 Min

Part C (3Q x 5M = 15Marks)

Q.No	Solution	Scheme of Marking	Max. Time required for each Question
14.	$X1 = \begin{matrix} 0 & 1 & 0 \\ 0 & 0 & 0 \\ 1 & 0 & 1 \end{matrix}$ $X2 = \begin{matrix} 1 & 0 & 1 \\ 1 & 1 & 0 \\ 0 & 0 & 0 \end{matrix}$ $X3 = \begin{matrix} 1 & 1 & 1 \\ 1 & 1 & 1 \\ 0 & 1 & 1 \end{matrix}$ $X4 = \begin{matrix} 0 & 1 & 0 \\ 0 & 0 & 1 \\ 0 & 1 & 1 \end{matrix}$ $X5 = \begin{matrix} 0 & 0 & 0 \\ 0 & 0 & 1 \\ 0 & 1 & 0 \end{matrix}$	1x5=5M	5 min
15. (a)	Soln: (i) For a binary image 1 bit is sufficient for representing a pixel value ∴ No of bits required = 1024 x 1024 x 1 = 1,048,576 bits (ii) For a gray image 8 bits are required for representing a pixel value ∴ No of bits required = 1024 x 1024 x 8 = 8,388,608 bits (iii) For a colour image (8x3=24 bits) 8 bits are required for representing a pixel value ∴ No of bits required = 1024 x 1024 x 24 = 25,165,824 bits	1+1+1=3M	5 min
15. (b)	Euclidean distance: $D_1 = \left[(x-0)^2 + (y-0)^2 + (3-0)^2\right]^{1/2}$ $= \left[(3-0)^2 + (2-0)^2 + (3-0)^2\right]^{1/2}$ $= \left[(3)^2 + (2)^2 + (3)^2\right]^{1/2}$ $= \sqrt{18} = 4.24$	1+1=2M	5 min

16.	Addition= $\begin{matrix} 14 & 17 & 38 \\ 25 & 11 & 22 \\ 27 & 16 & 15 \end{matrix}$ Subtraction= $\begin{matrix} 3 & 5 & 22 \\ 23 & 5 & 8 \\ 9 & 12 & 5 \end{matrix}$ Multiplication= $\begin{matrix} 28 & 66 & 240 \\ 24 & 24 & 105 \\ 162 & 28 & 50 \end{matrix}$	1.5+1.5+2=5M	5 min

Roll No.													

PRESIDENCY UNIVERSITY
BENGALURU

SCHOOL OF ENGINEERING

TEST – 2

Sem & AY: Odd Sem 2019-20
Course Code: ECE 307
Course Name: DIGITAL IMAGE PROCESSING
Program & Sem: B.Tech (ECE) & V

Date: 16.11.2019
Time: 2.30 PM to 3.30 PM
Max Marks: 40
Weightage: 20%

Instruction:
(i) Read the question properly and answer accordingly.
(ii) Question paper consists of 3 parts.
(iii) Scientific and Non-programmable calculators are permitted.

Part A [Memory Recall Questions]

Answer all the Questions. Each sub question carries one mark. **(10Qx1M=10M)**

1. Fill in the blanks with correct answers (C.O.NO.2) [Knowledge]

a) In bit plane slicing, a 512 level gray scale image will have _____ number of 1-bit planes.

b) A plot of p(rk) versus rk is called _____.

c) The general form of log transformation is s =_____.

d) The negative of a 2*2 image with pixel values $\begin{matrix} 0 & 4 \\ 3 & 6 \end{matrix}$ is _____.

e) In cathode ray tube (CRT) devices, if γ (gamma) = 2.5, the display system would produce images that are _____ in appearance.

f) If the components of the histogram are concentrated on lower side of the intensity scale then the image looks _____ in appearance

g) The process of highlighting masses of water in satellite imagery and enhancing flaws in X-ray images is called _____.

h) If input image intensities r1=r2 and output intensities s1=0, s2=L-1, this creates a binary image, this type of transformation is called _____.

i) The basic filtering equation in frequency domain is given by _____.

j) The frequency domain procedure for improving the appearance of an image based on illumination reflectance model is _____.

Part B [Thought Provoking Questions]

Answer all the Questions. Each Question carries five marks. **(3Qx5M=15M)**

(C.O.NO.2) [Comprehension]

2. Explain the model of image degradation/ restoration process with relevant equations.
(C.O.NO.2) [Comprehension]
3. List the steps for filtering in frequency domain.
(C.O.NO.2) [Comprehension]
4. Define bit plane slicing. For a given image, perform bit plane slicing.

$$\begin{bmatrix} 4 & 3 & 2 & 1 \\ 3 & 1 & 2 & 4 \\ 5 & 1 & 6 & 2 \\ 2 & 3 & 5 & 6 \end{bmatrix}$$

Part C [Problem Solving Questions]

Answer all the Questions. Each Question carries five marks. **(3Qx5M=15M)**

(C.O.NO.2) [Comprehension]

5. For a 3 bit 4*4 size image f(x,y) given below, perform the following operations
   a) Thresholding with T=4.
   b) Intensity level slicing with background and without background. The range of interest of intensity values is r1=3 and r2=5.

$$f(x,y) = \begin{bmatrix} 1 & 2 & 3 & 0 \\ 2 & 4 & 6 & 7 \\ 5 & 2 & 4 & 3 \\ 3 & 2 & 6 & 1 \end{bmatrix}$$

(C.O.NO.2) [Comprehension]

6. Consider a gray scale image in matrix form, perform histogram equalization on this image and scale the intensity to 1:20.

$$\begin{bmatrix} 3 & 2 & 4 & 5 \\ 7 & 7 & 8 & 2 \\ 3 & 1 & 2 & 3 \\ 5 & 4 & 6 & 7 \end{bmatrix}$$

(C.O.NO.2) [Comprehension]

7. Consider a triangle with vertices (0,0), (1,0), (1,1). This triangle is rotated 90 degrees clockwise, draw the original location of this triangle and also the new transformed figure with coordinates.

SCHOOL OF ENGINEERING

GAIN MORE KNOWLEDGE
REACH GREATER HEIGHTS

Semester: 5

Course Code: ECE307

Course Name: DIGITAL IMAGE PROCESSING

Date: 16/11/2019

Time: 2:30 PM TO 3:30 PM

Max Marks: 40

Weightage: 20%

Extract of question distribution [outcome wise & level wise]

Q.NO	C.O.NO	Unit/Module Number/Unit /Module Title	Memory recall type [Marks allotted] Bloom's Levels			Thought provoking type [Marks allotted] Bloom's Levels			Problem Solving type [Marks allotted]			Total Marks
			K			C			C			
1a - j	C.O.2	Module 2 (10 Objective Type Questions)	10									10
2-4	C.O.2	Module2 and 3(Subjective Type Questions)				5	5	5				15
5-7	C.O.2	Module2(Subjective Type Questions)							5	5	5	15
	Total Marks			10			15			15		40

K =Knowledge Level C = Comprehension Level, A = Application Level

Note: While setting all types of questions the general guideline is that about 60%

Of the questions must be such that even a below average students must be able to attempt, About 20% of the questions must be such that only above average students must be able to attempt and finally 20% of the questions must be such that only the bright students must be able to attempt.

Annexure- II: Format of Answer Scheme

GAIN MORE KNOWLEDGE REACH GREATER HEIGHTS

SCHOOL OF ENGINEERING

SOLUTION

Semester: 5

Course Code: ECE307

Course Name: DIGITAL IMAGE PROCESSING

Date: 16/11/2019

Time: 2:30PM TO 3:30PM

Max Marks: 40

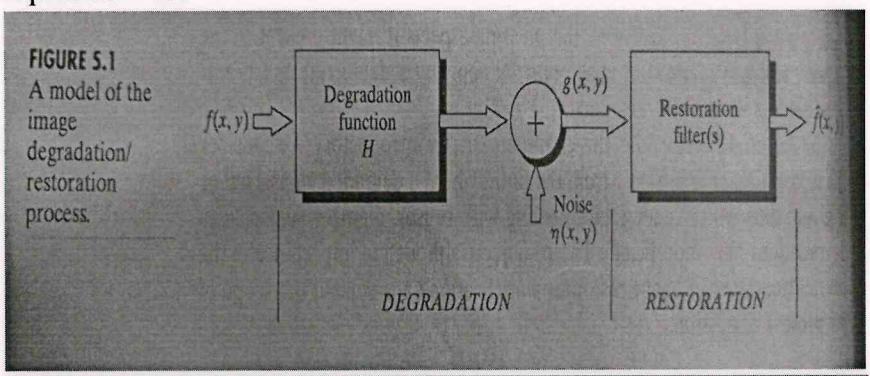
Weightage: 20

Part A (10Q x 1M =10 Marks)

Q No	Solution	Scheme of Marking	Max. Time required for each Question
1A	9	1 Mark	1 MIN
B	Normalized histogram of input image	1 Mark	1 MIN
C	s = c log(1+r)	1 Mark	1 MIN
D	7 3 4 6	1 Mark	1 MIN
E	Dark	1 Mark	1 MIN
F	Dark	1 Mark	1 MIN
G	Intensity level slicing	1 Mark	1 MIN
H	Thresholding Function	1 Mark	1 MIN
I	g(x,y)= IDFT[H(u,v)F(u,v)]	1 Mark	1 MIN
J	Homomorphic filtering	1 Mark	1 MIN

Part B (3Q x 5M = 15 Marks)

Q No	Solution	Scheme of Marking	Max. Time required for each Question
2.	Block diagram – 2m Explanation – 2m Equations – 1m	2+2+1	7 MIN

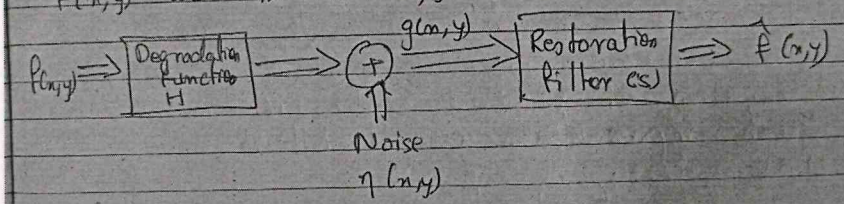


A model of the Image Degradation / Restoration Process

A degradation function, together with an additive noise term operates on an input image f(x,y) to produce a degraded image g(x,y).

Given g(x,y), some knowledge about the degradation function H and some knowledge about the additive noise term η(x,y) we can restore an estimate f̂(x,y) of the original image.

More we know about H and η the closer f̂(x,y) will be to f(x,y)



If H is a linear, position-invariant process then the degraded image is given in the spatial domain by

$$g(x,y) = h(x,y) * f(x,y) + \eta(x,y)$$

Frequency Domain:

$$G(u,v) = H(u,v)F(u,v) + N(u,v)$$

Better Scan and Insert instead of Camera Picture (Mobile App Cam Scanner may be used)

3.	**4.7.3 Summary of Steps for Filtering in the Frequency Domain** The material in the previous two sections can be summarized as follows: 1. Given an input image $f(x, y)$ of size $M \times N$, obtain the padding parameters P and Q from Eqs. (4.6-31) and (4.6-32). Typically, we select $P = 2M$ and $Q = 2N$. 2. Form a padded image, $f_p(x, y)$, of size $P \times Q$ by appending the necessary number of zeros to $f(x, y)$. 3. Multiply $f_p(x, y)$ by $(-1)^{x+y}$ to center its transform. 4. Compute the DFT, $F(u, v)$, of the image from step 3. 5. Generate a real, symmetric filter function, $H(u, v)$, of size $P \times Q$ with center at coordinates $(P/2, Q/2)$.† Form the product $G(u, v) = H(u, v)F(u, v)$ using array multiplication; that is, $G(i, k) = H(i, k)F(i, k)$. 6. Obtain the processed image: $$g_p(x, y) = \{\text{real}[\Im^{-1}[G(u, v)]]\}(-1)^{x+y}$$ where the real part is selected in order to ignore parasitic complex components resulting from computational inaccuracies, and the subscript p indicates that we are dealing with padded arrays. 7. Obtain the final processed result, $g(x, y)$, by extracting the $M \times N$ region from the top, left quadrant of $g_p(x, y)$. Steps 1 to 4 = 0.5 mark each Steps 5 to 7 = 1 mark each	**5**	**7 MIN**
4.	The process of highlighting the contribution of specific bits in all pixels of an image is called bit plane slicing transformation. -1m Representing the images in 3 bits – 1m MSB plane – 1m Center plane – 1m LSB plane -1m	**1+ 4**	**7 MIN**

(b) Bit - plane Slicing

4	3	2	1
3	1	2	4
5	1	6	2
2	3	5	6

100	011	010	001
011	001	010	100
101	001	110	010
010	011	101	110

Breaking it into planes

MSB plane → Left most bit

Center plane → Central bit

LSB plane → Right most bit

1	0	0	0
0	0	0	1
1	0	1	0
0	0	1	1

MSB plane

0	1	1	0
1	0	1	0
0	0	1	1
1	1	0	1

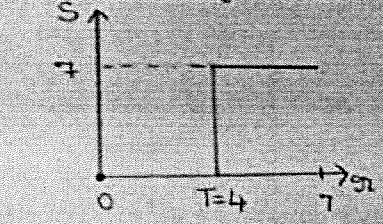
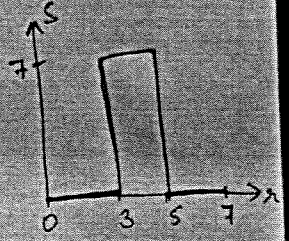
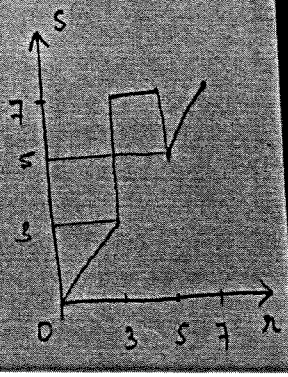
Center bit plane

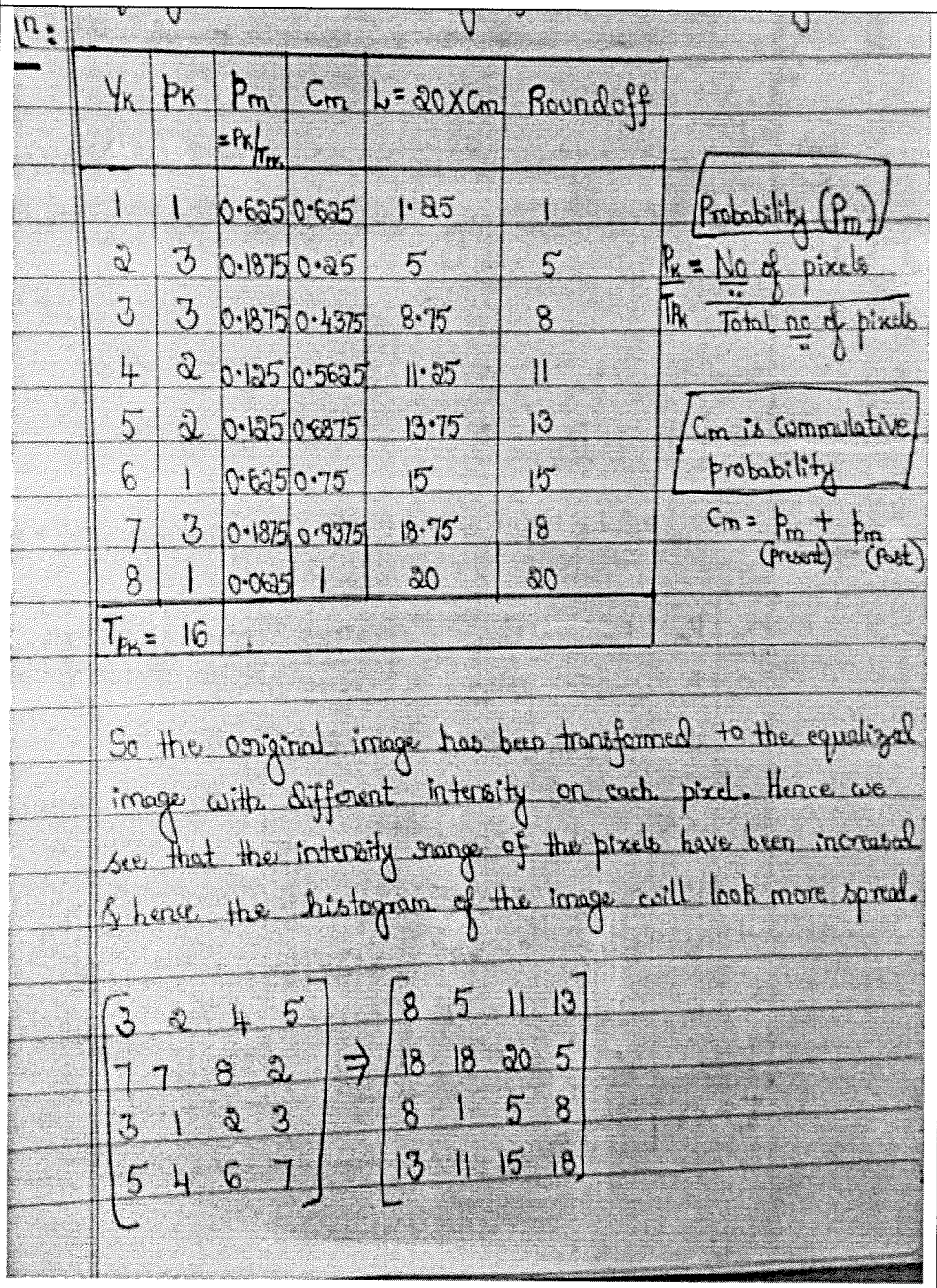
0	1	0	1
1	1	0	0
1	1	0	0
0	1	1	0

LSB plane

Part C (3Qx 5M =15 Marks)

Q No	Solution	Scheme of Marking	Max. Time required for each Question

5a	Soln: $2^3 = 8$ levels Thresholding : (i)  $g(x,y) = \begin{cases} 0 & \text{if } f(x,y) < 4 \\ 7 & \text{if } f(x,y) \geq 4 \end{cases}$ $g(x,y) = \begin{bmatrix} 0 & 0 & 0 & 0 \\ 0 & 7 & 7 & 7 \\ 7 & 0 & 7 & 0 \\ 0 & 0 & 7 & 0 \end{bmatrix}$	**2+1.5+ 1.5**	**8 MIN**
5b	a) Without background $S = \begin{cases} (L-1)=7 & 3 \leq r \leq 5 \\ 0 & \text{otherwise} \end{cases}$  $\therefore g(x,y) = \begin{bmatrix} 0 & 0 & 7 & 0 \\ 0 & 7 & 0 & 0 \\ 7 & 0 & 7 & 7 \\ 7 & 0 & 0 & 0 \end{bmatrix}$ b) with background $g(x,y) = S = \begin{cases} (L-1)=7 & 3 \leq r \leq 5 \\ r & \text{otherwise.} \end{cases}$  $\therefore g(x,y) = \begin{bmatrix} 1 & 2 & 7 & 0 \\ 2 & 7 & 6 & 7 \\ 7 & 2 & 7 & 7 \\ 7 & 2 & 6 & 1 \end{bmatrix}$ **Thresholding – 2m** **Intensity level slicing with background – 1.5m**		

	Intensity level slicing without background – 1.5m		
6		**3+1+1**	**8 MIN**

Ans:

Y_K	P_K	$P_m = P_K / T_K$	C_m	$L = 20 \times C_m$	Roundoff
1	1	0.625	0.625	1.85	1
2	3	0.1875	0.25	5	5
3	3	0.1875	0.4375	8.75	8
4	2	0.125	0.5625	11.25	11
5	2	0.125	0.6875	13.75	13
6	1	0.625	0.75	15	15
7	3	0.1875	0.9375	18.75	18
8	1	0.0625	1	20	20
T_K =	16				

Probability (P_m)

P_K = No of pixels / T_K = Total no of pixels

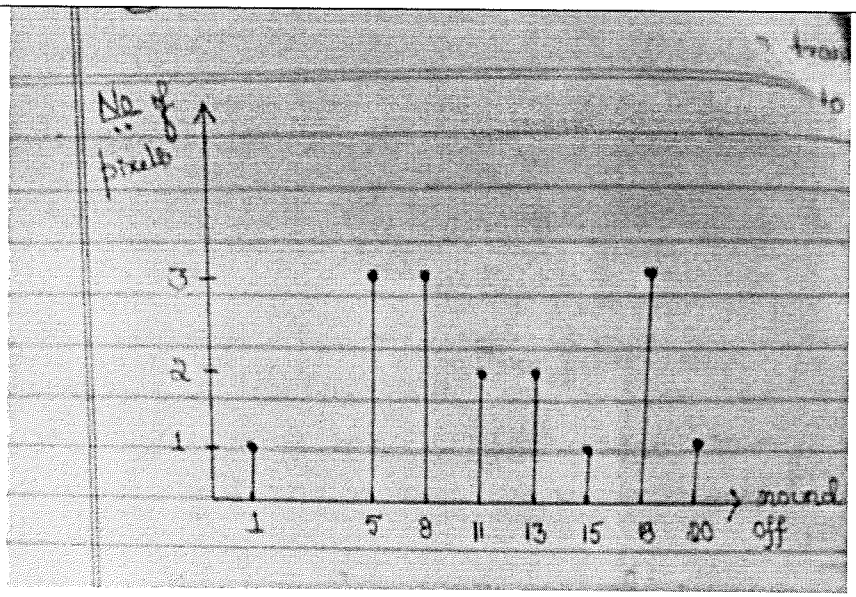
C_m is Commulative probability

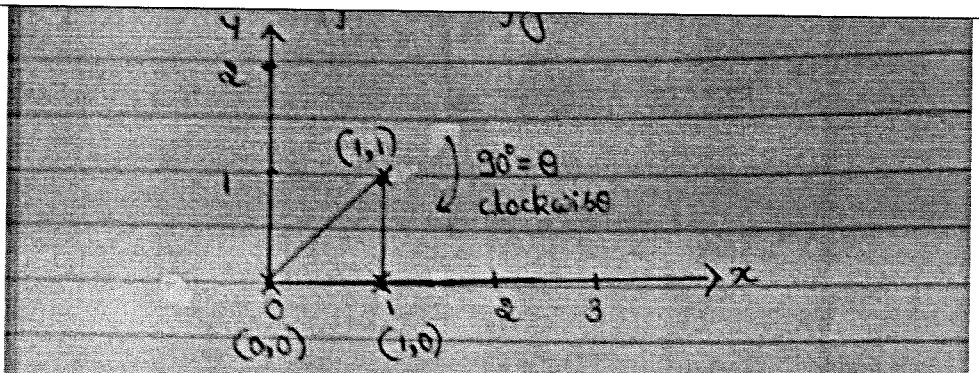
$C_m = P_m$ (present) + P_m (Past)

So the original image has been transformed to the equalized image with different intensity on each pixel. Hence we see that the intensity range of the pixels have been increased & hence the histogram of the image will look more spread.

$$\begin{bmatrix} 3 & 2 & 4 & 5 \\ 7 & 7 & 8 & 2 \\ 3 & 1 & 2 & 3 \\ 5 & 4 & 6 & 7 \end{bmatrix} \Rightarrow \begin{bmatrix} 8 & 5 & 11 & 13 \\ 18 & 18 & 20 & 5 \\ 8 & 1 & 5 & 8 \\ 13 & 11 & 15 & 18 \end{bmatrix}$$

Output histogram

	 **Table – 3m** **Output histogram – 1m** **Input image and transformed image intensities values in matrix form– 1m**		
7	**Original location of triangle with coordinates – 1m** **New tranformed figure with coordinates– 1m** **For each vertices finding the new vertices - 1m each**	**1+1+1+ 1+1**	**8 MIN**



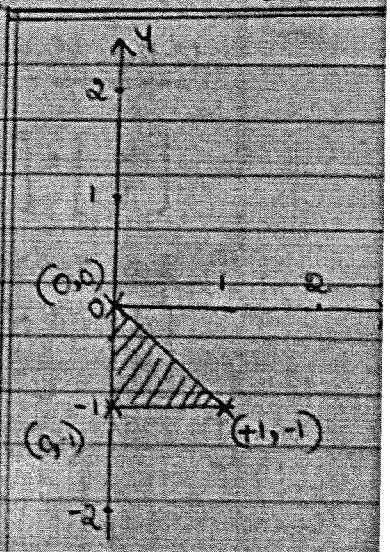
W.K.t for Rotation (clockwise):

$$\begin{bmatrix} x' \\ y' \end{bmatrix} = \begin{bmatrix} \cos\theta & \sin\theta \\ -\sin\theta & \cos\theta \end{bmatrix} \begin{bmatrix} x \\ y \end{bmatrix}$$

$\sin 90 = 1$

$\cos 90 = 0$

$$\therefore \begin{bmatrix} x' \\ y' \end{bmatrix} = \begin{bmatrix} 0 & 1 \\ -1 & 0 \end{bmatrix} \begin{bmatrix} x \\ y \end{bmatrix}$$



(i) for (0,0) & $\theta = 90°$

$$\begin{bmatrix} x' \\ y' \end{bmatrix} = \begin{bmatrix} 0 & 1 \\ -1 & 0 \end{bmatrix} \begin{bmatrix} 0 \\ 0 \end{bmatrix} = \begin{bmatrix} 0 \\ 0 \end{bmatrix}$$

(ii) for (1,0) & $\theta = 90°$

$$\begin{bmatrix} x' \\ y' \end{bmatrix} = \begin{bmatrix} 0 & 1 \\ -1 & 0 \end{bmatrix} \begin{bmatrix} 1 \\ 0 \end{bmatrix} = \begin{bmatrix} 0 \\ -1 \end{bmatrix}$$

(iii) for (1,1) & $\theta = 90°$

$$\begin{bmatrix} x' \\ y' \end{bmatrix} = \begin{bmatrix} 0 & 1 \\ -1 & 0 \end{bmatrix} \begin{bmatrix} 1 \\ 1 \end{bmatrix} = \begin{bmatrix} 1 \\ -1 \end{bmatrix}$$

Roll No											

PRESIDENCY UNIVERSITY
BENGALURU

SCHOOL OF ENGINEERING

END TERM FINAL EXAMINATION

Semester: Odd Semester: 2019-20 **Date**: 28 December 2019

Course Code: ECE 307 **Time**: 9:30 AM to 12:30 PM

Course Name: DIGITAL IMAGE PROCESSING **Max Marks**: 80

Program & Sem: B.Tech (ECE) & V (DE–I) **Weightage**: 40%

Instructions:

(i) Read the all questions carefully and answer accordingly.

(ii) All Questions are compulsory.

Part A [Memory Recall Questions]

Answer all the Questions. Each Question carries 1 mark. (10Qx1M=10M)

1. Formulate the basic form of Power law transformation? (C.O.No.2) [Knowledge]
2. For given 3x3 image obtain the negative transformation of an image (C.O.No.2) [Knowledge]

1	0	1
1	1	1
0	0	0

3. What is the process of correcting the power-law response phenomena in display devices? (C.O.No.2) [Knowledge]
4. Define Unitary Matrix? (C.O.No.2) [Knowledge]
5. Define and formulate Translation and Reflection in Morphological Image Processing? (C.O.No.4) [Knowledge]
6. Consider the two image segments shown by A and B. If $A=\begin{bmatrix}0 & 0\\ 1 & 1\end{bmatrix}$ and $B=\begin{bmatrix}1 & 1\\ 1 & 1\end{bmatrix}$ find A XOR B and A AND B (C.O.No.1) [Knowledge]
7. Specify the components of Digital Image Processing? (C.O.No.1) [Knowledge]
8. List the steps involved in Digital Image Processing? (C.O.No.1) [Knowledge]
9. List the steps in digitizing the continuous Image? (C.O.No.1) [Knowledge]
10. Define and formulate Compression Ratio? (C.O.No.3) [Knowledge]

Part B [Thought Provoking Questions]

Answer all the Questions. Each Question carries 10 marks. (3Qx10M=30M)

11. Define Morphology? Given an image A and structuring element B. Compute:(i) A Dilated by B ($A \oplus B$) (C.O.No.4) [Comprehension]
(ii) A Erosion by B ($A \ominus B$)

(iii) A^c Erosion by B ($A^c \ominus B$)

A

0	0	0	0	0	0
0	0	1	1	0	0
0	1	1	1	1	0
0	0	1	1	0	0
0	0	0	0	0	0

B

1
1
1

12. Explain how multi-resolution analysis can be done using image pyramids. With a neat block diagram explain the steps involved in for obtaining approximation and Prediction residual pyramids. (C.O.No.4) [Comprehension]

13. With neat diagrams, write a brief note on: (C.O.No.4) [Comprehension]
    I. RGB Color model
    II. Intensity level Slicing

Part C [Problem Solving Questions]

Answer all the Questions. Each Question carries 10 marks. (4Qx10M=40M)

14. a) Let p and q are two pixels at co-ordinates (10,15) and (15,25) respectively.
    Compute: i) Euclidean distance ii) Chessboard distance and
    iii) City Block distance.
    And conclude which determines minimum distance.

    b) Given $f1 = \begin{bmatrix} 0 & 2 \\ 2 & 3 \end{bmatrix}$, $f2 = \begin{bmatrix} 6 & 5 \\ 4 & 7 \end{bmatrix}$, a1=1 a2= -1 and H= max. Determine weather it is a Linear operation or non-Linear operation. (C.O.No.1) [Comprehension]

15. Perform histogram equalization of the following 8x8 image. The gray level distribution of the image is given below. Draw the input and output histogram. (C.O.No.2) [Comprehension]

Gray level r_k	0	1	2	3	4	5	6	7
No of pixels n_k	8	10	10	2	12	16	4	2

16. An information source produces a sequence of independent symbols having the following probabilities. Construct a binary code using Huffman encoding and find the average length of this code for the following symbols. (C.O.No.3) [Comprehension]

Symbol	s1	s2	s3	s4	s5	s6	s7
Probability	0.4	0.2	0.1	0.1	0.1	0.05	0.05

17. Given an image strip corresponds to the intensity profile, and the numbers in the boxes are the intensity values of the dots shown in the profile. Highlight the Edge, line and isolated point in the input image strip. (C.O.No.3) [Comprehension]
    (i) State the first order and second order derivative equations.
    (ii) Draw the intensity for the image strip
    (iii) Obtain the First Order Derivative and Second order Derivative of the image strip.

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

Reviewer Commend:
DR. M. LEVY

Format of Answer Scheme

GAIN MORE KNOWLEDGE
REACH GREATER HEIGHTS

SCHOOL OF ENGINEERING

SOLUTION

Semester: Odd Sem. 2019-20
Course Code: ECE307
Course Name: Digital Image Processing
Program & Sem: SOE & 5th

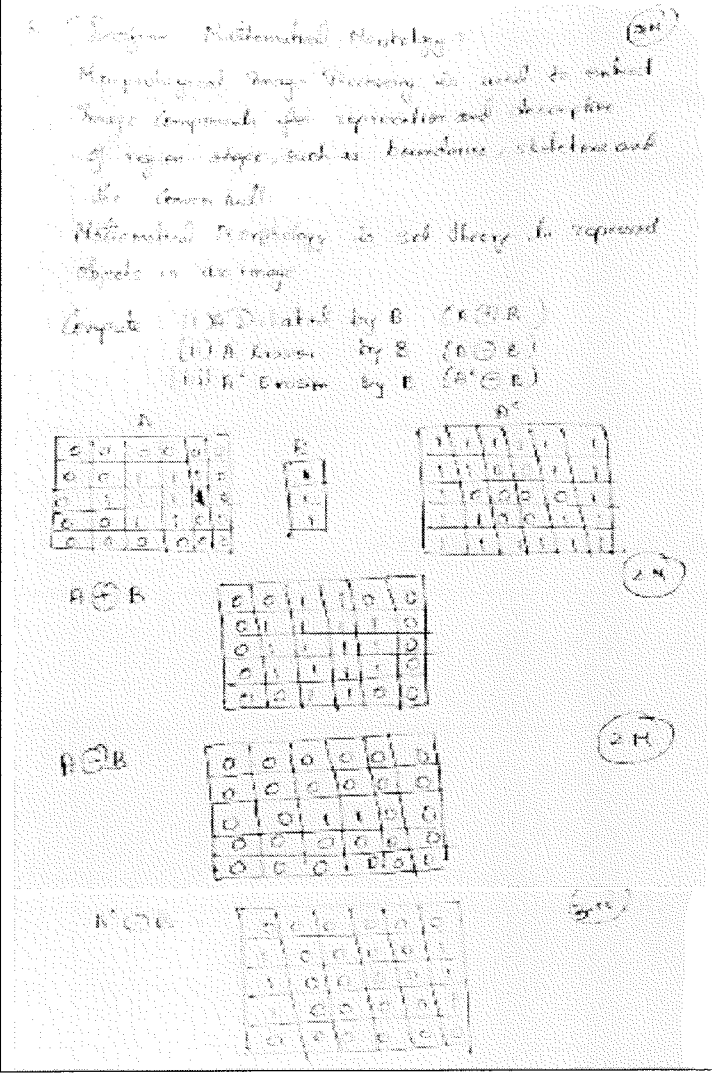
Date: 28 .12.2019
Time: 3 HRS
Max Marks: 80
Weightage: 40%

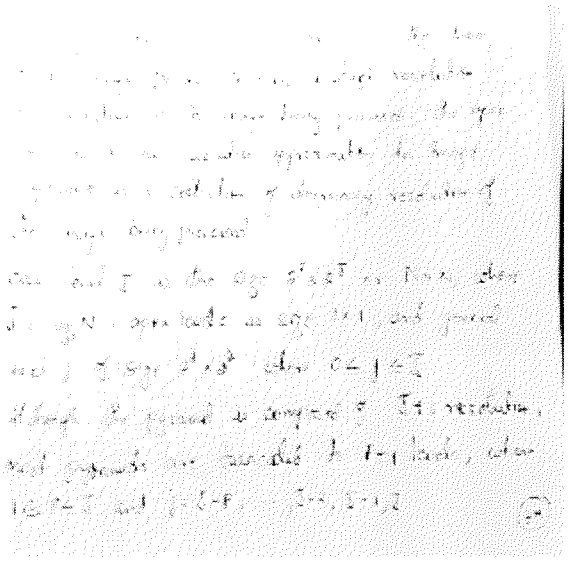
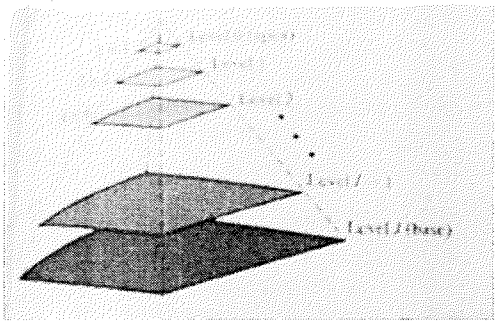
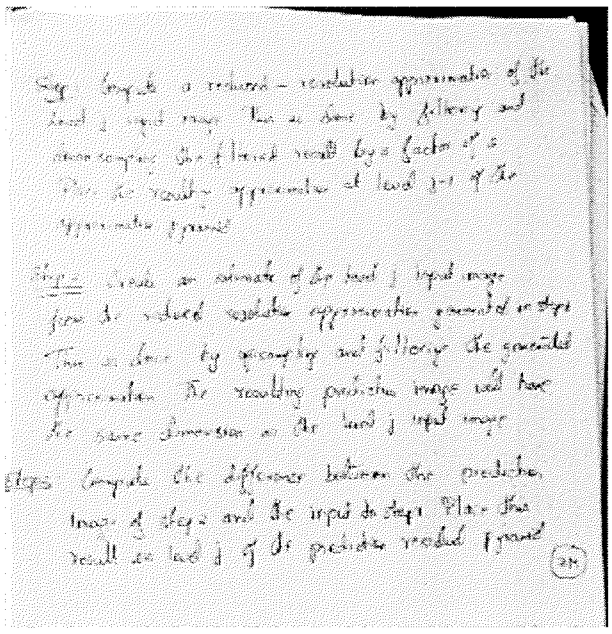
Part A (10Q x 1M = 10Mark

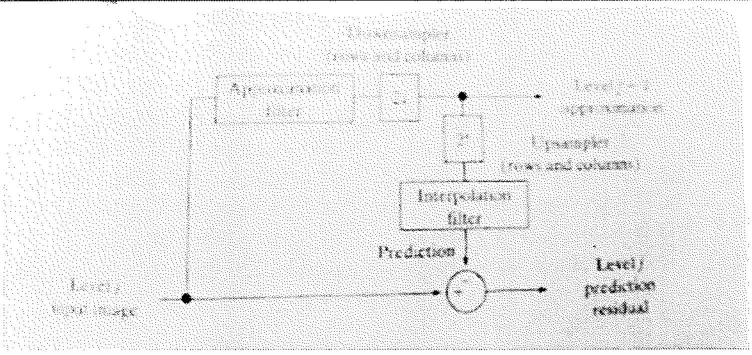
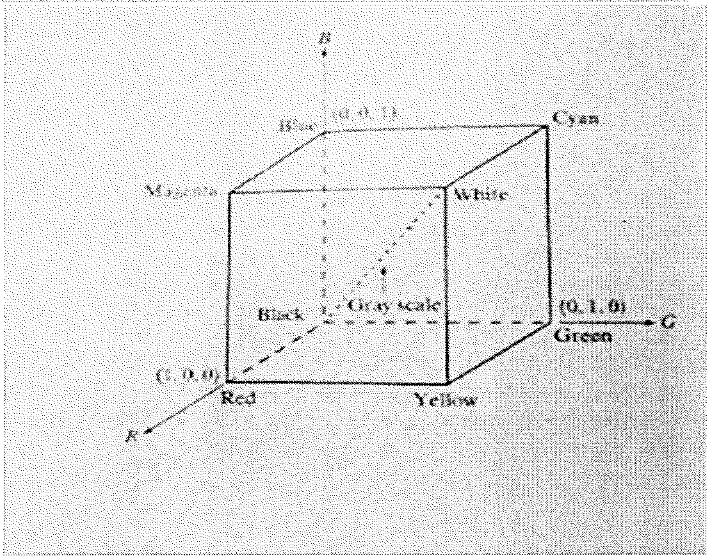
Q No	Solution	Scheme of Marking	Max. Time required for each Question
1	S=c.r^{γ} where c= Constant and 0<r<L-1	1	1min
2	$\begin{bmatrix} 0 & 1 & 0 \\ 0 & 0 & 0 \\ 1 & 1 & 1 \end{bmatrix}$	1	1min
3	Gamma Correction	1	1min
4	Unitary Matrix $A^{-1} = A^{*T}$ Matrix A is called Unitary matrix if A inverse is equal to A conjugate transpose	1	1min
5	Reflection $B' = w \mid w = -b, \ for \ \ b \in B\}$ Translation $B_z = \{c \mid c = b + z$	1	1min
6	A XOR B =$\begin{bmatrix} 1 & 1 \\ 0 & 0 \end{bmatrix}$ A AND B=$\begin{bmatrix} 0 & 0 \\ 1 & 1 \end{bmatrix}$	1	1min
7	Image Display Computer Mass Storage Hardcopy Specialized image processing Hardware Image Processing Software Image sensor Network	1	1min

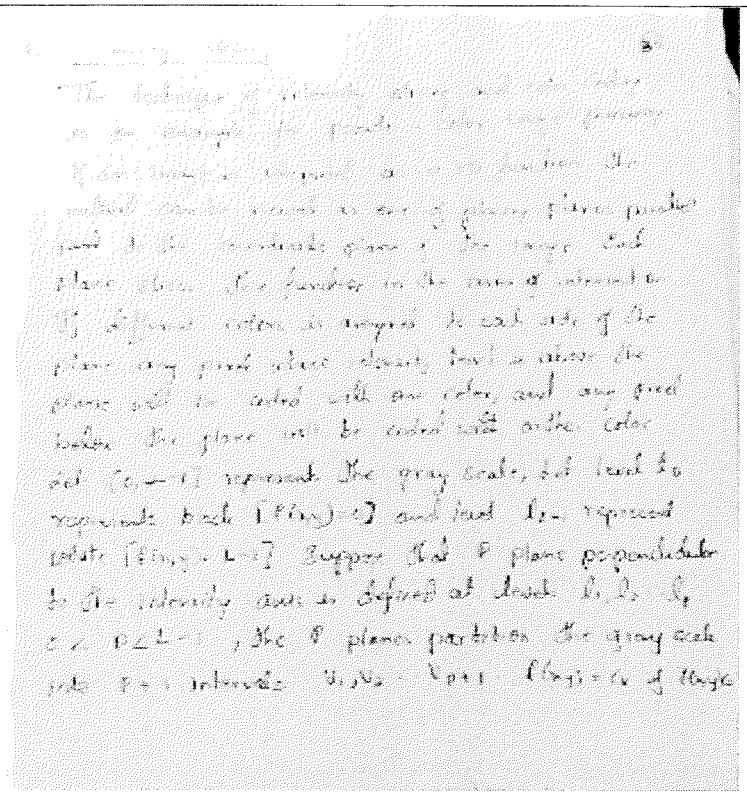
8	Image Acquisition Image Enhancement Image Restoration Color Image Processing Wavelets and Multi-resolution analysis Compression Morphological Image processing Segmentation Representation and Description Object Recognition	**1**	**1min**
9	Sampling and Quantization	**1**	**1min**
10	Compression Ration=$\frac{Original\ Image}{Compressed\ Image}$	**1**	**1min**

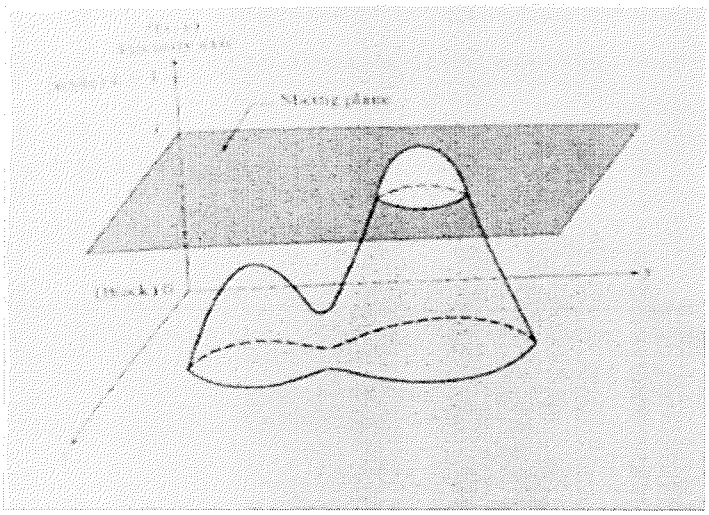
Part B (3Q x 10M = 30 Marks)

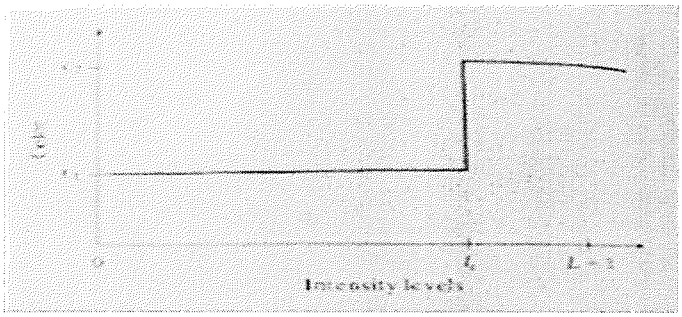
Q No	Solution	Scheme of Marking	Max. Time required for each Question
2		3+2+2+3	20min

3	 **Image Pyramid Diagram**  	3+2+3+2	20min

	 		
4	RGB Color Model In the RGB color model, each color appears in its primary spectral components of red, green and blue. This model is based on a Cartesian coordinate system. The color subspace of interest is the cube in which RGB primary values are at three corners, the secondary colors cyan, magenta and yellow are at three other corners, black is at the origin and white is at the corner farthest from the origin. The gray scale extends from black to white along the line joining these two points. The different colors in this model are points inside the cube and are defined by vectors extending from the origin. RGB - 8 bits (each), so 24-bit RGB image is $(2^8)^3 = 16,777,216$  	3+2+3+2	20min

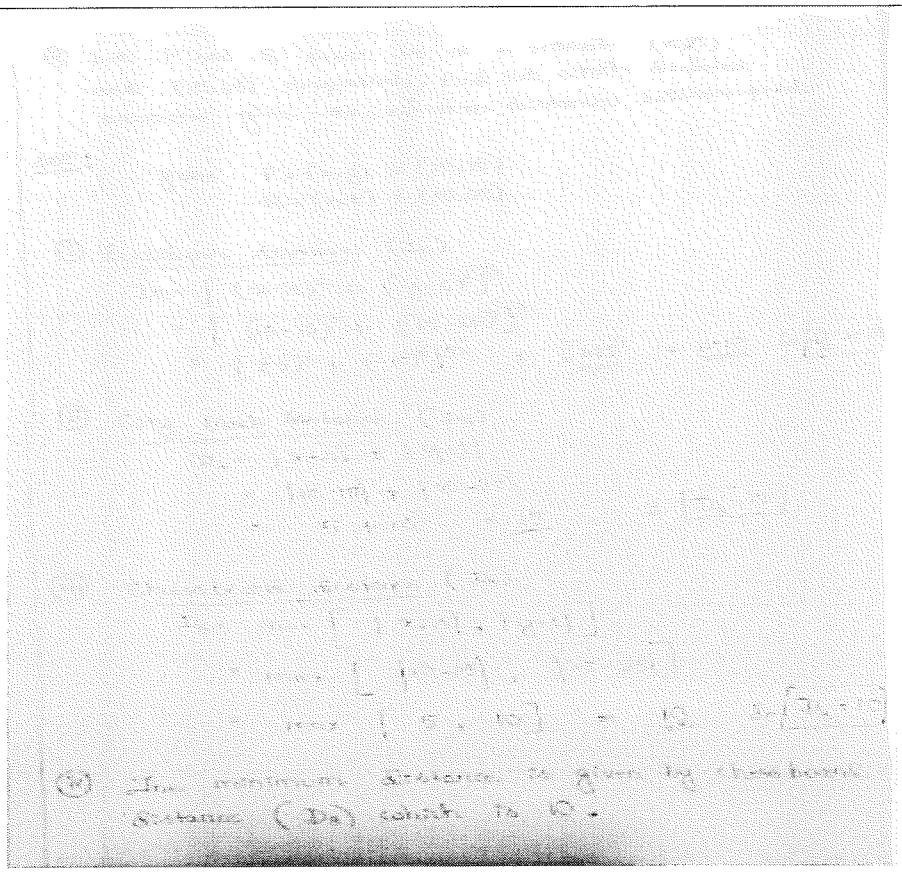


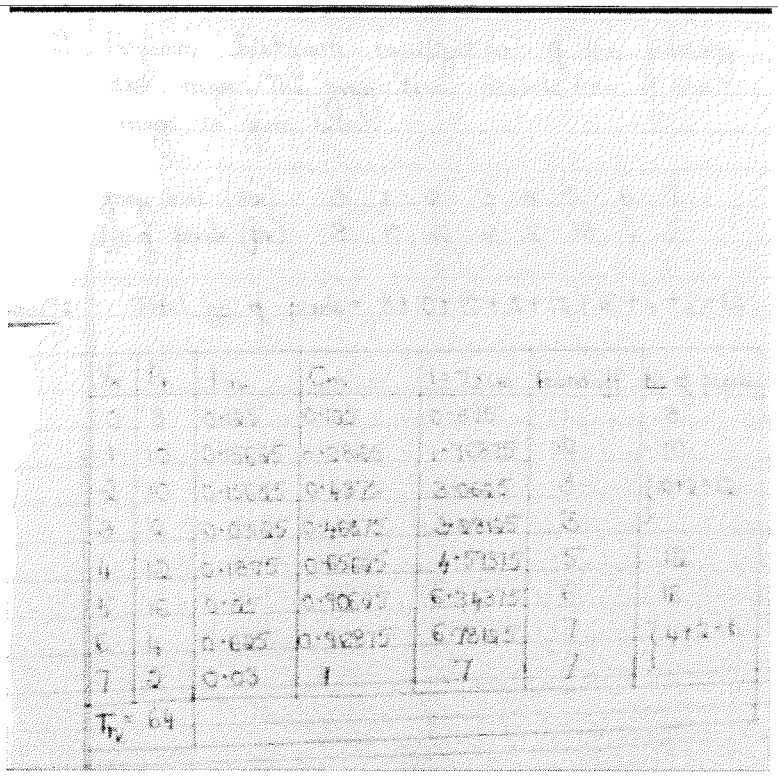




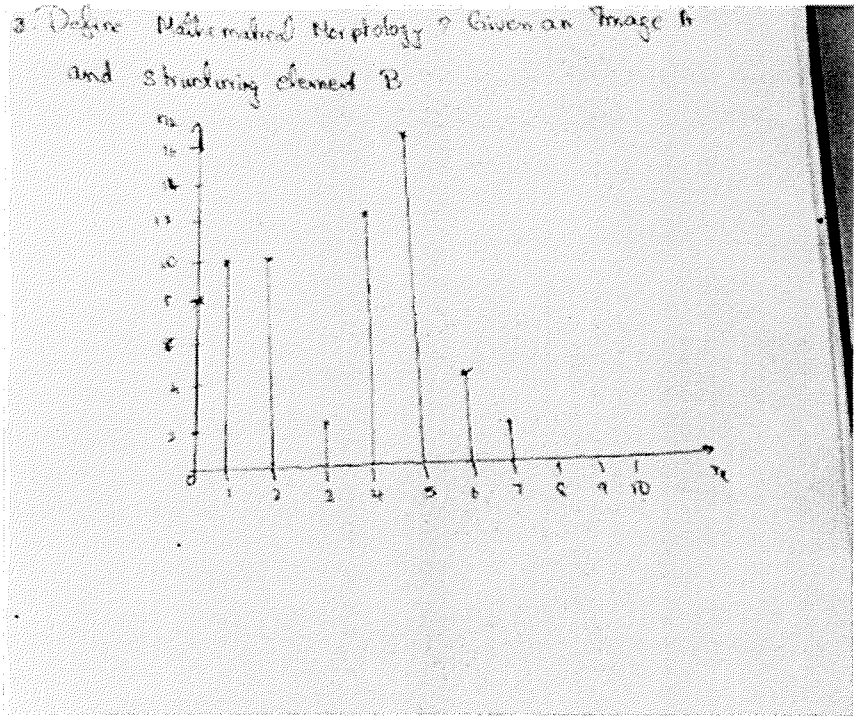
Part C (0Q x 0M = 0Marks)

	Solution		Max. Time required

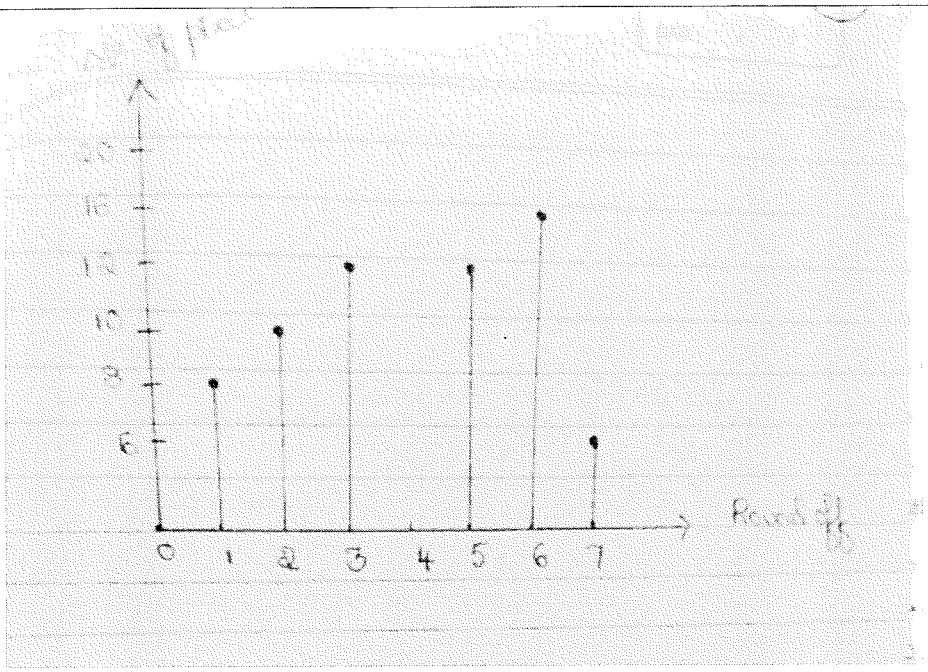
Q No		Scheme of Marking	for each Questior
5a		1.5+1.5+1.5+ 0.5	20min
5b	$f_1 = \begin{bmatrix} 0 & 2 \\ 2 & 3 \end{bmatrix}$ and $f_2 = \begin{bmatrix} 6 & 5 \\ 4 & 7 \end{bmatrix}$ and suppose that we let $a_1 = 1$ and $a_2 = -1$. To test for linearity, we again start with the left side of Eq. (2.6-2): $\max\left\{(1)\begin{bmatrix} 0 & 2 \\ 2 & 3 \end{bmatrix} + (-1)\begin{bmatrix} 6 & 5 \\ 4 & 7 \end{bmatrix}\right\} = \max\left\{\begin{bmatrix} -6 & -3 \\ -2 & -4 \end{bmatrix}\right\}$ $= -2$ Working next with the right side, we obtain $(1)\max\left\{\begin{bmatrix} 0 & 2 \\ 2 & 3 \end{bmatrix}\right\} + (-1)\max\left\{\begin{bmatrix} 6 & 5 \\ 4 & 7 \end{bmatrix}\right\} = 3 + (-1)7$ $= -4$ Max operator is a non linear Operator	2+2+1	

6		5+2+3	20min

Input Histogram



Output Histogram



7			6+2+2	20min

Source Symbols	p_i	Code	Source S_a		Source S_b		Source S_c		Source S_d		Source S_e	
			p_i	Code	p_i	Code	p_i	Code	p_i	Code	p_i	Code
s_1	0.4	1	0.4	1	0.4	1	0.4	1	0.4	1	0.6	0
s_2	0.2	01	0.2	01	0.2	01	0.2	01	0.4	00	0.4	1
s_3	0.1	0010	0.1	0010	0.2	000	0.2	000	0.2	01		
s_4	0.1	0011	0.1	0011	0.1	0010	0.2	001				
s_5	0.1	0000	0.1	0000	0.1	0011						
s_6	0.05	00010	0.1	0001								
s_7	0.05	00011										

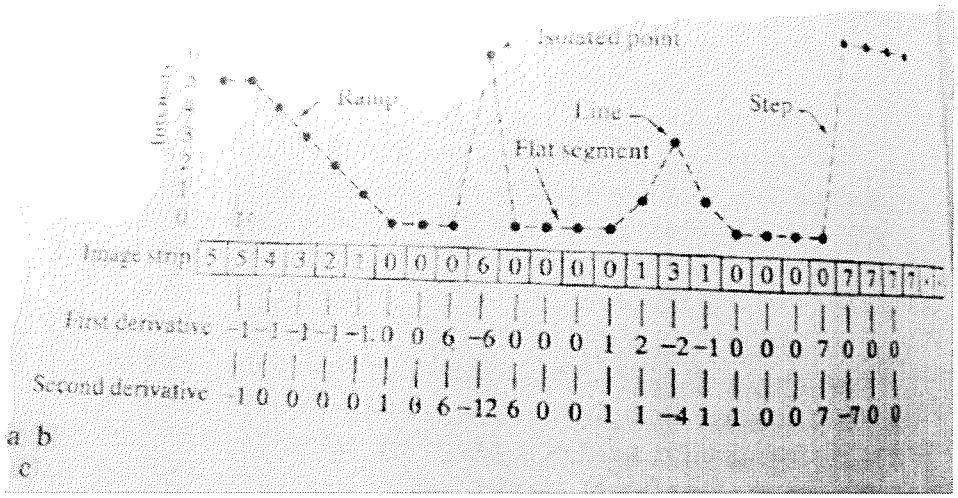
Table 2.45 : Code-table for example 2.27 with composite symbol placed "as low as possible"

The average length L is given by,

$$L = \sum_{i=1}^{7} p_i l_i$$

$$= (0.4)(1) + (0.2)(2) + (0.1)(4) + (0.1)(4) + (0.1)(4) + (0.05)(5) + (0.05)(5)$$

$$= 2.5 \text{ binits/message-symbol}$$

8	 First-order derivative $$\frac{\partial f}{\partial x} = f'(x) = f(x+1) - f(x)$$ Second-order derivative $$\frac{\partial^2 f}{\partial x^2} = f(x+1) + f(x-1) - 2f(x)$$	2+3+3+1+1	20min