IE 404 – Digital Image Processing
Dhirubhai Ambani Institute of Information and Communication Technology (DA-IICT)
End-Sem Examination, November 2019

[Time – 2 Hour 30 Minutes]
[Total Marks - 65]

Instructions:
- **There are 2 double sided pages (4 printed pages). Ensure that you have all the pages.**
- **Question paper contains 2 sections (A, and B).**
  - **Section A contains 20 multiple choice questions, 1 mark will each question.**
  - **Section B contains 3 descriptive questions, 15 marks for each question.**
- **Answer all question. All questions are self-explanatory and understanding of question is a part of evaluation.**
- **No query regarding questions will entertained during examination by course instructor or invigilator.**

Section A

1. Formula $p_r = n/MN$ represents the
   - **A. Coding redundancy**
   - B. Spatial redundancy
   - C. Temporal redundancy
   - D. Irrelevant info

2. Histogram equalization refers to image
   - A. Sampling
   - B. Quantization
   - C. Framing
   - **D. Normalization**

3. Redundancy of data can be found using formula
   - **A. 1-(1/c)**
   - B. 1+(1/c)
   - C. 1-(-1/c)
   - D. (1/c)

4. Image can be blurred using
   - **A. Low pass filter**
   - B. Contouring
   - C. Erosion
   - D. High pass filter

5. Brightness of light is a subject
   - A. Oriented
   - **B. Descriptor**
   - C. Matter
   - D. Defined

6. Color of an object is determined by light
   - A. Refracted
   - B. Transmitted
   - **C. Reflected**
   - D. Absorbed

7. Visible spectrum ranges
   A. 300-600 nm
   B. 400-700 nm
   C. 500-800 nm
   D. 600-900 nm

8. For line detection we use mask that is
   A. Gaussian
   B. Laplacian
   C. Ideal
   D. Butterworth

9. Gradient magnitude images are more useful in
   A. Point detection
   B. Line detection
   C. Area detection
   D. Edge detection

10. For noise reduction we use
   A. Image smoothing
   B. Image contouring
   C. Image enhancement
   D. Image recognition

11. For edge detection we use
   A. First derivative
   B. Second derivative
   C. Third derivative
   D. Both A and B

12. Sobel gradient is not that good for detection of
   A. Horizontal lines
   B. Vertical lines
   C. Diagonal lines
   D. Edges

13. Example of similarity approach in image segmentation is
   A. Edge based segmentation
   B. Boundary based segmentation
   C. Region based segmentation
   D. Both A and B

14. Reflection and translation of image objects are based on
   A. Pixels
   B. Frames
   C. Structuring elements
   D. Coordinates

15. With dilation process images get
   A. Thinner
   B. Thickened
   C. Shrinked
   D. Sharpened

16. Power law transformation is useful in
   A. Purification
   B. Industry
   C. Radar
   D. MRI

17. Product of two functions in spatial domain is what, in frequency domain

A. Correlation
B. Convolution
C. Fourier transform
D. Fast Fourier transform

18. Types of imaging sensors are

A. Two
B. Three
C. Four
D. Five

19. Image linear interpolation is given by formula

A. v(x,y) = ax+by+cxy+d
B. v(x,y) = ax+by+cxy
C. v(x,y) = ax+by+d
D. v(x,y) = by+cxy+d

20. Visible red light is used in

A. Soil moisture
B. Mineral mapping
C. Water penetration
D. Vegetation discrimination

Section B

21. Consider the following image A, and let the structuring element be B.

$$A = \begin{bmatrix} 23 & 21 & 32 & 31 & 28 & 26 \\ 88 & 45 & 29 & 51 & 67 & 39 \\ 64 & 23 & 33 & 35 & 32 & 24 \\ 15 & 20 & 125 & 190 & 143 & 120 \\ 34 & 255 & 24 & 0 & 26 & 123 \\ 75 & 145 & 29 & 51 & 67 & 39 \end{bmatrix} \qquad B = \begin{bmatrix} 0 & 1 & 0 \\ 1 & 1 & 1 \\ 0 & 1 & 0 \end{bmatrix}$$

Perform the following operations

(I) A^C

-22	-20	-31	-30	-27	-25
-87	-44	-28	-50	-66	-38
-63	-22	-32	-34	-31	-23
-14	-19	-124	-189	-142	-119
-33	-254	-23	1	-25	-122
-74	-144	-28	-50	-66	-38

(II) $A \oplus B$

88	45	32	51	67	39
88	88	51	67	67	67
88	64	125	190	143	120
64	255	190	190	190	143
255	255	255	190	143	123
145	255	145	67	67	123

(III) $A \Theta B$

21	21	21	28	26	26
23	21	29	29	28	24
15	20	23	32	24	24
15	15	20	0	26	24
15	20	0	0	0	26
34	29	24	0	26	39

(IV) $A^C \oplus B$

-20	-20	-20	-27	-25	-25
-22	-20	-28	-28	-27	-23
-14	-19	-22	-31	-23	-23
-14	-14	-19	1	-25	-23
-14	-19	1	1	1	-25
-33	-28	-23	1	-25	-38

(V) $A^C \Theta B$

-87	-44	-31	-50	-66	-38
-87	-87	-50	-66	-66	-66
-87	-63	-124	-189	-142	-119
-63	-254	-189	-189	-189	-142
-254	-254	-254	-189	-142	-122
-144	-254	-144	-66	-66	-122

(VI) $(A \Theta B) \oplus B$

23	21	29	29	28	26
23	29	29	32	29	28
23	23	32	32	32	24
15	20	23	32	26	26
34	29	24	0	26	39
34	34	29	26	39	39

(VII) $(A \oplus B) \Theta B$

23	21	32	31	28	26
88	45	32	51	67	39
64	64	51	67	67	24
15	64	125	190	143	120
34	255	145	67	67	123
75	145	29	51	67	39

22. (A). 4 x 4 original image with 4 bits per pixel is given by [10,12,8,9; 10,12,12,14; 12,13,10,9; 14,12,10,12]

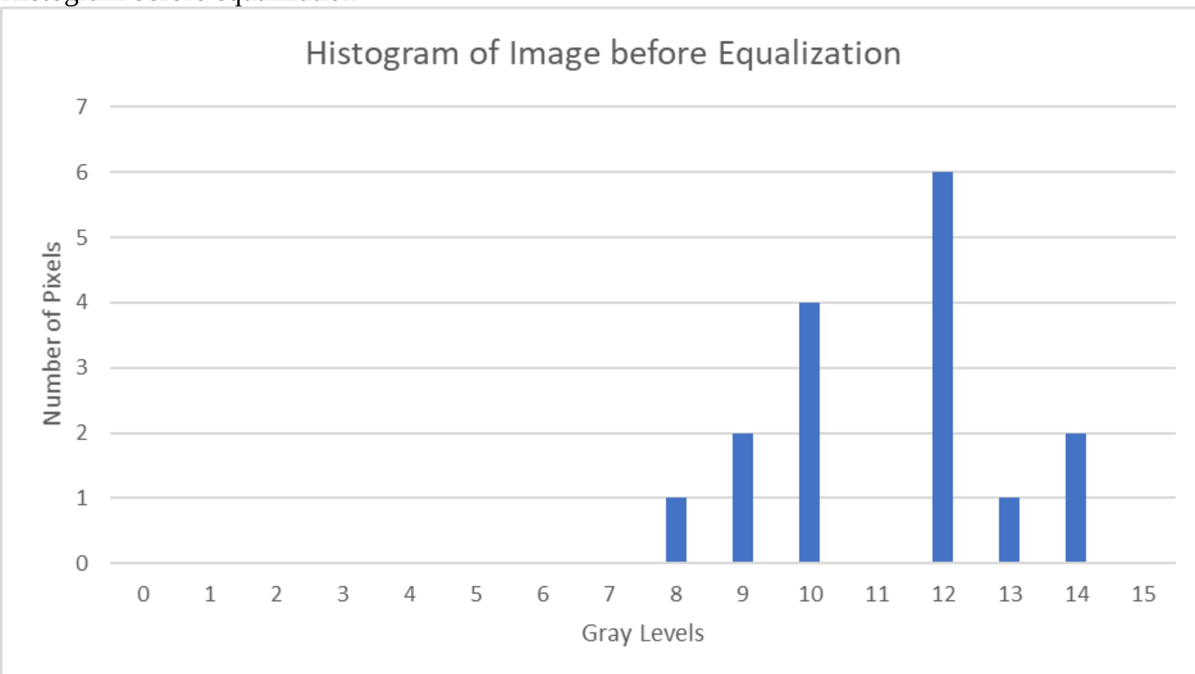
(i). Apply histogram equalization to the image by rounding image pixels to integers.

(ii). Sketch the histogram of the original image and histogram equalized image

10	12	8	9
10	12	12	14
12	13	10	9
14	12	10	12

Gray Level	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
No. of Pixels	0	0	0	0	0	0	0	0	1	2	4	0	6	1	2	0

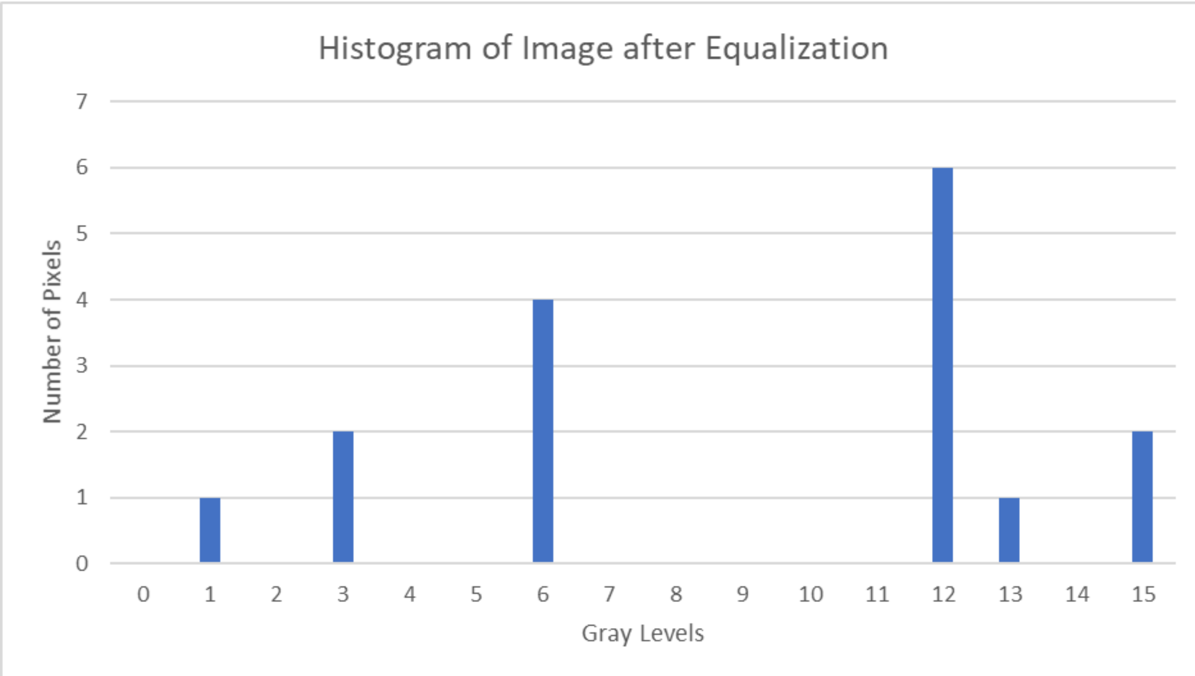
Histogram before equalization



Gray Level	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
No. of Pixels	0	0	0	0	0	0	0	0	1	2	4	0	6	1	2	0
$\sum_{j=0}^{k} n_j$	0	0	0	0	0	0	0	0	1	3	7	7	13	14	16	16
$s = \sum_{j=0}^{k} \frac{n_j}{n}$	0/ 16	0/ 16	0/ 16	0/ 16	0/ 16	0/ 16	0/ 16	0/ 16	1/ 16	3/ 16	7/ 16	7/ 16	13/16	14/16	16/16	16/16
	0	0	0	0	0	0	0	0	0.06	0.19	0.44	0.44	0.81	0.87	1	1
S * 15	0	0	0	0	0	0	0	0	0.9	2.85	6	6	12.15	13.05	15	15
	0	0	0	0	0	0	0	0	1	3	6	6	12	13	15	15

After Equalization

Gray Level	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
No. of Pixels	0	1	0	2	0	0	4	0	0	0	0	0	6	1	0	2



(B). Determine the Convolution and Correlation between the following two images $f(x,y)$ and $g(x,y)$

$$f(x,y)=\begin{bmatrix}0&0&0&0&0\\0&0&0&1&0\\0&0&1&0&0\\0&1&0&1&0\\0&0&0&0&1\end{bmatrix} \quad \textbf{and} \;\; g(x,y)=\begin{bmatrix}1&2&3\\4&5&6\\7&8&9\end{bmatrix}$$

Convolution

0	0	0	0	0	0	0
0	0	0	1	2	3	0
0	0	1	6	8	6	0
0	1	6	16	16	12	0
0	4	12	18	15	8	3
0	7	8	16	12	14	6
0	0	0	0	7	8	9

Correlation

0	0	0	0	0	0	0
0	0	0	9	8	7	0
0	0	9	14	12	4	0
0	9	14	24	14	8	0
0	6	8	12	15	12	7
0	3	2	4	8	6	4
0	0	0	0	3	2	1

23. (A). **Consider an image that uses a window of size 5 × 5. The gray level values inside the 5 × 5 Sub-image are 15,17,15,17,16,10,8,9,18,15,16,12,14,11,15,14,15,11,100,15,14,13,12,12,17**

What values could Assign to the central pixel of this sub-image by using following filter

1) A local averaging filter (mean)

2) A median filter

3) A mode filter

4) A max filter

5) A min filter

(i). Mean Filter	17.24
(ii). Median Filter	15
(iii). Mode Filter	15
(iv). Max Filter	100
(v). Min Filter	8

(B). Find the DFT transform of the image shown below:

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

2D Discrete Fourier Transform (DFT)

$$F[k,l]=\frac{1}{MN}\sum_{m=0}^{M-1}\sum_{n=0}^{N-1} f[m,n]e^{-j2\pi\left(\frac{k}{M}m+\frac{l}{N}n\right)}$$