Techno India NJR Institute of Technology

Course File

Image Processing and

Pattern Recognitation (7EX5-13)

Vivek Jain

(Associate Professor)

Department of ECE

RAJASTHAN TECHNICAL UNIVERSITY, KOTA

Scheme & Syllabus

IV Year- VII & VIII Semester: B. Tech. (Electrical and Electronics Engineering)

7EX5-13: IMAGE PROCESSING AND PATTERN RECOGNITION

Credit: 3   Max. Marks: 150(IA:30, ETE:120)

3L+0T+0P   End Term Exam: 3 Hours

SN	CONTENTS	Hours
1	**Introduction:** Objective, scope and outcome of the course.	1
2	**Imaging in ultraviolet and visible band:** Fundamental steps in image processing. Components inimage processing. Image perception in eye, light and electromagnetic spectrum, Image sensing and acquisition using sensor array.	7
3	**Digital Image Fundamentals:** Image sampling and quantization, Representing digital images, Spatial and gray-level resolution, Aliasing and Moiré patterns, zooming and Shrinking digital images.	8
4	**Image Restoration:** Image restoration model, Noise Models, Spatial and frequency properties of noise, noise probability density functions. Noise - only spatial filter, Mean filter Statistic filter and adaptive filter, Frequency domain filters - Band reject filter, Band pass filter and Notch filter.	8
5	**Image Compression:** Compression Fundamentals - Coding Redundancy, Interpixel redundancy, Psycho visual redundancy and Fidelity criteria. Image Compression models, Source encoder and decoder. Channel encoder and decoder, Lossy compression and compression standards. Color space formats, scaling methodologies (like horizontal, vertical up/down scaling). Display format (VGA, NTSC, P AL).	8
6	**Expert System and Pattern Recognition:** Use of computers in problem solving, information representation, searching, theorem proving, and pattern matching with substitution. Methods for knowledge representation, searching, spatial, temporal and common sense reasoning, and logic and probabilistic inferencing. Applications in expert systems and robotics.	8
	TOTAL	

	Text/Reference Books
1	Rafael C. Gonzalez: Digital Image Processing, Pearson Education, Asia. 2009
2	Vipula Singh: Digital Image Processing, Elesvier. 2013
3	Nick Effard: Digital Image Processing, Pearson Education, Asia. 2000
4	Jain A. K.: Digital Image Processing, Prentice Hall of India 1989
5	Shinghal: Pattern Recognition- Techniques and Applications, Oxford. 2006 Jayaraman: Digital Image Processing, TMH. 2011

Office of Dean, Academic Affairs

Rajasthan Technical University, Kota

For Techno India NJR Institute of Technology

पंकज पोरवाल

Dr. Pankaj Kumar Porwal

(Principal)

Course Overview:

For the last few decades, image processing has emerged as an important technology to extract useful information for scene understanding. To develop next-generation image processing systems, it is essential to equip our students with a deep understanding of the challenges in image understanding, and with advanced skills to develop image processing techniques by integrating approaches from information processing and pattern recognition. This course will provide both basic and in-depth coverage of image processing techniques for students to develop information processing systems. In particular, this course will help students understand many image processing approaches for scene analysis and understanding; to acquire working knowledge of many image processing systems; to have a hands-on experience on analyzing a variety of images for image understanding.

Course Outcomes:

CO.NO.	Cognitive Level	Course Outcome
1	**Comprehension**	Able to generate different Continuous and Discrete time signals.
2	**Application**	Develop image enhancement, compression and edge detection using MATLAB.
3	**Analysis**	Design and Develop IIR & FIR Filter using different approximation methods using MATLAB.
4	**Synthesis**	Implement algorithms for image processing on DSP Processor.
5	**Evaluation**	Evaluate the signal to noise ration of the image.

Prerequisites:
1. Fundamentals knowledge of Fourier transform .
2. Fundamentals knowledge of LTI system.
3. Fundamentals knowledge of Z transform and Basic signals.

Course Outcome Mapping with Program Outcome:

Course Outcome	Program Outcomes (PO's)											
CO. NO.	Domain Specific					Domain Independent						
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	1	1	0	0	1	0	0	0	0	1
CO2	3	2	3	2	3	0	0	0	0	0	0	0
CO3	3	2	3	2	3	0	0	0	0	0	0	0
CO4	0	1	1	0	2	0	0	2	0	0	0	1
CO5	1	1	2	1	3	0	0	0	0	0	0	1
1: Slight (Low) , 2: Moderate (Medium), 3: Substantial (High)												

Course Coverage Module Wise:

Lecture No.	Unit	Topic
1	**2**	**DIGITAL IMAGE FUNDAMENTALS**: Image Sensing and acquisition,Image sampling and quantization
2	2	Representing digital image
3	2	Spatial and gray-level resolution
4	2	Spatial operations, Vector & matrix operations
5	2	Zooming and Shrinking of digital images
6	2	RGB and HSI Color models
7	**3**	**BASIC IMAGE OPERATIONS:** Intensity Transformation functions
8	3	Histogram equalization
9	3	Spatial filtering for image smoothing
10	3	Image sharpening by first and second order derivatives
11	3	Image smoothing filters
12	3	Image sharpening filters
13	3	Frequency domain filters
14	3	Frequency domain filters
15	**4**	**IMAGE RESTORATION:**Image restoration model
16	4	Noise Models, Spatial and frequency properties of noise
17	4	Noise probability density functions

18	4	Spatial filter: Mean filter, Mode Filter, Median Filter
19	4	Spatial filter: Mean filter, Mode Filter, Median Filter
20	4	Adaptive filters
21	4	Concepts of inverse filter
22	4	Concepts of Wiener filtering
23	**5**	**MORPHOLOGICAL IMAGE PROCESSING:** Erosion and Dilation
24	5	Opening
25	5	Closing
26	5	Morphological algorithms for Boundary extraction
27	5	Thinning
28	5	Pruning
29	5	Smoothing
30	5	Thickening
31	**6**	**IMAGE SEGMENTATION AND COMPRESSION:** Edge based segmentation
32	6	Edge detection masks
33	6	Gradient operators
34	6	Thresholding
35	6	Region growing
36	6	Watershed transform
37	6	Fundamentals of image compression
38	6	Loss-less compression techniques
39	6	Lossy compression techniques
40	6	Compression standards

NPTEL COUSES LINK
nptel.ac.in/courses/106/105/106105032/

Faculty Notes Link
drive.google.com/drive/folders/1tAwtx2mkh7srQlHIgQBF_2zVrx3I0nKD?usp=sharing

For Techno India Nor...
पंकज पोरवाल
Dr. Pankaj Kumar Porwal
(Principal)

QUIZ Link
1. www.sanfoundry.com/digital-image-processing-mcqs-image-sampling-quantization/
2. compsciedu.com/Category/Digital-Image-Processing-(DIP)
3. mcqslearn.com/cs/dip/digital-image-processing-mcqs-questions-and-answers.php

Assessment Methodology:

1. Practical exam using MATALB software.
2. Two Midterm exams where student have to showcase subjective learning.
3. Final Exam (subjective paper) at the end of the semester.

TECHNO INDIA NJR INSTITUTE OF TECHNOLOGY UDAIPUR
Computer Science and Engineering
B. TECH III– YEAR (VI Sem)
SUBJECT 6CS301
Digital Image Processing

Assignment Sheet I

Q1   Explain in details the different acquisition techniques of digital image processing.(CO1)

Q2   Explain in details what is the different roll of sampling & quantization in digital image processing.(CO1)

Q3 . What is image segmentation? Explain Point, Edge and Line detector.(CO2)

Q4. Explain in details different types of intensity transformation function in image processing.(CO2)

 Q5

Gray Level	0	2	3	4	5	6	7	8
No of Pixels	30	40	65	70	50	25	40	20

Perform histogram stretching so that the new image has a dynamic range of (0,8).(CO5)

Q6. Explain in details Spatial filtering operation for digital image smoothing.(CO4)

Q7. Explain in details different types of noise and noise models for image restoration. Also define different probability density function of noise models and plot the frequency response.(CO4)

Q8(a) Determine and display the two-dimensional Fourier transform of a thin rectangular object. The object should be 2 by 10 pixels in size and solid white against a black background. Display the Fourier transform as both a function (i.e., as a mesh plot) and as an image plot.

(b) Fourier transform of the horizontal chirp signal shown in Figure 1 the spatial frequency characteristics of this image are zero in the vertical direction since the image is constant in this direction. The linear increase in spatial frequency in the horizontal direction is reflected in the more or less constant

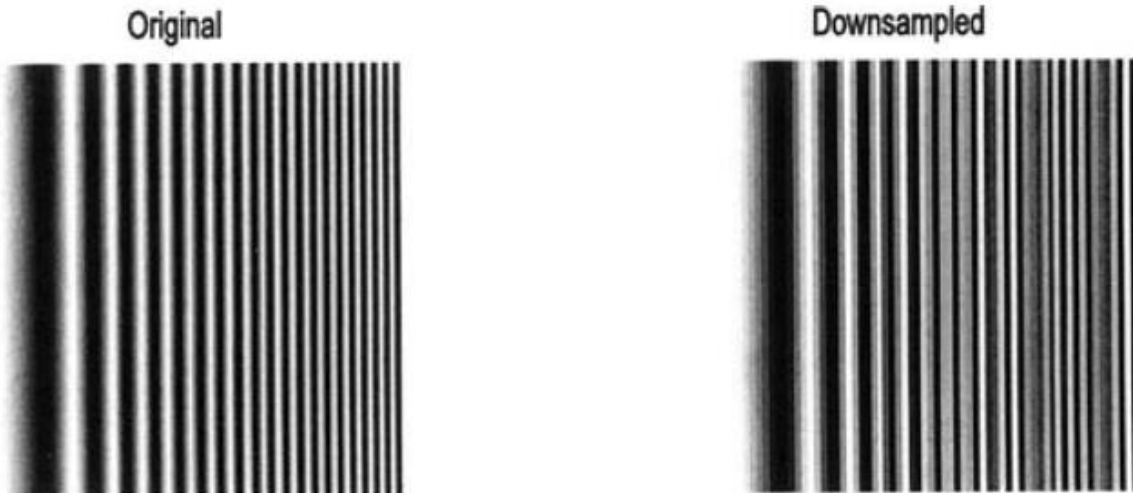   Amplitude of the Fourier transform in this direction. (CO5)

Figure 1

TECHNO INDIA NJR INSTITUTE OF TECHNOLOGY UDAIPUR
Computer Science and Engineering
B. TECH III– YEAR (VI Sem)
SUBJECT 6CS301
Digital Image Processing

Assignment Sheet II

1(a) What is the difference between gray-level slicing with background suppressed and without background suppression? (CO1)

1(b) What is meant by bit-plane slicing? Give the algorithm to obtain the
      (i) eighth bit plane.
      (ii) sixth bit plane.

1(c) In spatial domain, derive the equation for Laplacian masks. Also, draw the different forms of the Laplacian mask.

Q2 Load one frame of the MRI image set and apply the sharpening soble filter to detect horizontal edges. Then apply the Sobel filter to detect the vertical edges and combine the two edge detectors. Plot both the horizontal and combined edge detectors.(CO4)

Q3 (a) Sketch the block diagram for homomorphic filtering along with the equations corresponding to each block.(CO2)

(b) Which filter is best suited to remove salt and pepper noise? Explain.

(c) Sate the algorithm for adaptive median filter. Explain various statistical parameters used.

Q4 Configuration for adaptive noise cancellation. The reference channel carries a signal, $N'(n)$, that is correlated with the noise, $N(n)$, but not with the signal of interest, $x(n)$. The adaptive filter produces an estimate of the noise, $N^*(n)$ that is in the signal. In some applications, multiple reference channels are used to provide a more accurate representation of the background noise.(CO5)

Q5 (a) Sate the algorithm for adaptive median filter. Explain various statistical parameters used.

(b) Explain inverse and Weiner filtering using suitable equations. Give the condition when Weiner filtering reduces to inverse filtering. (CO4)

Q6 Use the data in the table to obtain the arithmetic code word for the message a1 a2 a3 a3 a4. (CO2)

Source Symbol	Probability	Initial Subinterval
a_1	0.2	[0.0, 0.2)
a_2	0.2	[0.2, 0 4)
a_3	0 4	[0.4, 0.8)
a_4	0.2	[0.8, 1.0)

Q7 . Explain the following morphological algorithms in detail using suitable example(CO4)

(a) Boundary extraction.

(b) Region filling

(c) Connected components

(d) Thinning

(e) Thickening

Q8 Define different ways of image segmentation. Which method is better & why?(CO2)

Q9 Explain canny edge detector algorithm clearly stating different steps.(CO2)

TECHNO INDIA NJR INSTITUTE OF TECHNOLOGY UDAIPUR
Computer Science and Engineering
B. TECH III– YEAR (VI Sem)
SUBJECT 6CS301

Digital Image Processing

VIVA

Q 1. Define Image?

Q 2. Define Image Sampling?

Q 3. Define Quantization ?

Q4. Define Mach Band Effect?

Q5.Define Brightness?

Q6. Define Tapered Quantization?

Q7. What Do You Meant By Gray Level?

Q8. Define Resolutions?

Q9. Write The M X N Digital Image In Compact Matrix Form?

Q10. Write The Expression To Find The Number Of Bits To Store A Digital Image?

Q11. What Do You Meant By Zooming Of Digital Images?

Q12. What Do You Meant By Shrinking Of Digital Images?

Q13. Define The Term Radiance?

Q14. Define The Term Luminance?

Q15. What Is Image Transform?

Q16. What Are The Applications Of Transform?

Q17. Give The Conditions For Perfect Transform?

Q18. What Are The Properties Of Unitary Transform?

Q19. Write The Expression Of One-dimensional Discrete Fourier Transforms?

Q20. Properties Of Twiddle Factor?

Q21. Give The Properties Of One-dimensional DFT?

Q22. Give The Properties Of Two-dimensional DFT?

Q23. What Is Cosine Transform?

Q24. Write The Properties Of Cosine Transform?

Q25. Write The Properties Of Sine Transform?

Q26. Write The Properties Of Hadamard Transform?

Q27. Explain The Term Digital Image?

Q28. Explain The Term Digital Image?

Q29. Write Any Four Applications Of DIP?

Q30. What Is The Effect Of Mach Band Pattern?

Q31. Write Down The Properties Of 2d Fourier Transform?

Q32. What Is Image Enhancement?

Q33. Name The Categories Of Image Enhancement And Explain?

Q34. What Do You Mean By Point Processing?

Q35. What Is Image Negatives?

Q36. Define Histogram?

Q37. Define Derivative Filter?

Q38. Explain Spatial Filtering?

Q39. Define Averaging Filters?

Q40. What Is A Median Filter?

Q41. What Is Maximum Filter And Minimum Filter?

Q42. What Is A Adaptive Filter?

Q43. What role does the compression play in image processing?

Q44. What are the two types of image compression?

Q45. What is image compression algorithm?

TECHNO INDIA NJR INSTITUTE OF TECHNOLOGY UDAIPUR
Computer Science and Engineering
B. TECH III– YEAR (VI Sem)
SUBJECT 6CS301

Digital Image Processing

Quiz

1.What is Digital Image Processing?

a) It's an application that alters digital videos

b) It's a software that allows altering digital pictures

c) It's a system that manipulates digital medias

d) It's a machine that allows altering digital images

2. Which of the following process helps in Image enhancement?

   a) Digital Image Processing

   b) Analog Image Processing

   c) Both a and b

   d) None of the above

3. Among the following, functions that can be performed by digital image processing is?

    a) Fast image storage and retrieval

    b) Controlled viewing

    c) Image reformatting

    d) All of the above

4. Which of the following is an example of Digital Image Processing?

    a) Computer Graphics

    b) Pixels

    c) Camera Mechanism

    d) All of the mentioned

5. What are the categories of digital image processing?

    a) Image Enhancement

    b) Image Classification and Analysis

c) Image Transformation

d) All of the mentioned

6. How does picture formation in the eye vary from image formation in a camera?

a) Fixed focal length

b) Varying distance between lens and imaging plane

c) No difference

d) Variable focal length

7. What are the names of the various colour image processing categories?

a) Pseudo-color and Multi-color processing

b) Half-color and pseudo-color processing

c) Full-color and pseudo-color processing

d) Half-color and full-color processing

8. Which characteristics are taken together in chromaticity?

a) Hue and Saturation

b) Hue and Brightness

c) Saturation, Hue, and Brightness

d) Saturation and Brightness

9. Which of the following statement describe the term pixel depth?

a) It is the number of units used to represent each pixel in RGB space

b) It is the number of mm used to represent each pixel in RGB space

c) It is the number of bytes used to represent each pixel in RGB space

d) It is the number of bits used to represent each pixel in RGB space

10. The aliasing effect on an image can be reduced using which of the following methods?

a) By reducing the high-frequency components of image by clarifying the image

b) By increasing the high-frequency components of image by clarifying the image

c) By increasing the high-frequency components of image by blurring the image

d) By reducing the high-frequency components of image by blurring the image

11. Which of the following is the first and foremost step in Image Processing?

a) Image acquisition

b) Segmentation

c) Image enhancement

d) Image restoration

12. Which of the following image processing approaches is the fastest, most accurate, and flexible?
    a) Photographic
    b) Electronic
    c) Digital
    d) Optical

13. Which of the following is the next step in image processing after compression?
    a) Representation and description
    b) Morphological processing
    c) Segmentation
    d) Wavelets

14. _____ determines the quality of a digital image.
    a) The discrete gray levels
    b) The number of samples
    c) discrete gray levels & number of samples
    d) None of the mentioned

15. Image processing involves how many steps?
    a) 7
    b) 8
    c) 13
    d) 10

16. Which of the following is the abbreviation of JPEG?
    a) Joint Photographic Experts Group
    b) Joint Photographs Expansion Group
    c) Joint Photographic Expanded Group
    d) Joint Photographic Expansion Group

17. Which of the following is the role played by segmentation in image processing?
    a) Deals with property in which images are subdivided successively into smaller regions
    b) Deals with partitioning an image into its constituent parts or objects
    c) Deals with extracting attributes that result in some quantitative information of interest
    d) Deals with techniques for reducing the storage required saving an image, or

the bandwidth required transmitting it

18. The digitization process, in which the digital image comprises M rows and N columns, necessitates choices for M, N, and the number of grey levels per pixel, L. M and N must have which of the following values?
a) M have to be positive and N have to be negative integer
b) M have to be negative and N have to be positive integer
c) M and N have to be negative integer
d) M and N have to be positive integer

19. Which of the following tool is used in tasks such as zooming, shrinking, rotating, etc.?
a) Filters
b) Sampling
c) Interpolation
d) None of the Mentioned

20. The effect caused by the use of an insufficient number of intensity levels in smooth areas of a digital image _____
a) False Contouring
b) Interpolation
c) Gaussian smooth
d) Contouring

21. What is the procedure done on a digital image to alter the values of its individual pixels known as?
a) Geometric Spacial Transformation
b) Single Pixel Operation
c) Image Registration
d) Neighbourhood Operations

22. Points whose locations are known exactly in the input and reference images are used in Geometric Spacial Transformation.
a) Known points
b) Key-points
c) Réseau points
d) Tie points

23. _____ is a commercial use of Image Subtraction.
a) MRI scan

b) CT scan
c) Mask mode radiography
d) None of the Mentioned

24. Approaches to image processing that work directly on the pixels of incoming image work in _____
a) Spatial domain
b) Inverse transformation
c) Transform domain
d) None of the Mentioned

25. Which of the following in an image can be removed by using a smoothing filter?
a) Sharp transitions of brightness levels
b) Sharp transitions of gray levels
c) Smooth transitions of gray levels
d) Smooth transitions of brightness levels

26. Region of Interest (ROI) operations is generally known as _____
a) Masking
b) Dilation
c) Shading correction
d) None of the Mentioned

27. Which of the following comes under the application of image blurring?
a) Image segmentation
b) Object motion
c) Object detection
d) Gross representation

28. Which of the following filter's responses is based on the pixels ranking?
a) Sharpening filters
b) Nonlinear smoothing filters
c) Geometric mean filter
d) Linear smoothing filters

29. Which of the following illustrates three main types of image enhancing functions?
a) Linear, logarithmic and power law
b) Linear, logarithmic and inverse law

c) Linear, exponential and inverse law
d) Power law, logarithmic and inverse law

30. Which of the following is the primary objective of sharpening of an image?
a) Decrease the brightness of the image
b) Increase the brightness of the image
c) Highlight fine details in the image
d) Blurring the image

30. Which of the following operation is done on the pixels in sharpening the image, in the spatial domain?
a) Differentiation
b) Median
c) Integration
d) Average

QUIZ ANSWER KEY

Q1. B Q2. C Q3. D Q4. D Q5. D Q6 D Q7. C Q8. A Q9. D Q10. D Q11. A Q12. C Q13. B
Q14. C Q15. D Q16. A Q17. B Q18. D Q19. C Q20. A Q21. B Q22. D Q23. C Q24. A Q25 B
Q26. A Q27. D Q28. B Q29. D Q30. C

TECHNO INDIA NJR INSTITUTE OF TECHNOLOGY UDAIPUR
Computer Science and Engineering
B. TECH III– YEAR (VI Sem)
SUBJECT 6CS301
Digital Image Processing

Last Year RTU Question Paper

Time: 2 Hours

Maximum Marks: 48
Min. Passing Marks: 16

Instructions to Candidates:

Attempt **three questions,** *selecting* **one question each** *from any three* **unit.**
All Questions carry **equal** *marks. (Schematic diagrams must be shown wherever necessary. Any data you feel missing suitably be assumed and stated clearly. Units of quantities used/ calculated must be stated clearly.*

Use of following supporting material is permitted during examination. **(Mentioned in form No. 205)**

1. NIL _____   2. NIL _____

UNIT- I

Q.1 (a) Define the image. Explain the steps of digital image processing with suitable diagram.   [8]

(b) Explain the applications of digital image processing.   [8]

OR

Q.1 (a) Explain image sensing and acquisition.   [8]

(b) Explain color vision model with example.   [8]

UNIT- II

Q.2 (a) Explain why the discrete histogram equalization technique does not. in general, yield a flat histogram.   [8]

(b) Discuss the limiting effect of repeatedly applying a 3×3 low pass spatial filter to a digital image. You may ignore border effect.   [8]

[8E8162]   [6280]

Dr. Pankaj Kumar Porwal
(Principal)

OR

Q.2 Describe the various types of frequency domain filters. [16]

UNIT- III

Q.3 (a) Explain image degradation and restoration process. [8]

(b) Explain noise and inverse filtering. [8]

OR

Q.3 Design Homomorphic filtering. How do we get back the modified image? [16]

UNIT- IV

Q.4 (a) Describe Lossy compression techniques. [8]

(b) Explain Huffman coding with example. [8]

OR

Q.4 Write a short note on (any two): [2×8=16]

(a) Interpixel redundancy

(b) Psychovisual redundancy

(c) JPEG compression

(d) Coding redundancy

UNIT- V

Q.5 (a) Explain edge detection in detail. [8]

(b) Explain region based segmentation with suitable example. [8]

OR

Q.5 (a) Explain Hough transforms. [8]

(b) Explain about Thresholding. [8]

Q.2 Describes the various types of frequency domain filters. [16]

UNIT – III

Q.3 What is digital image restoration process? Explain noise probability density function. [16]

OR

Q.3 (a) Explain the adaptive median filter and also write application. [8]

(b) Explain the noise estimation parameter. [8]

UNIT – IV

Q.4 Explain the Hit–or–Miss transformation. How can we remove the noise from image by opening and closing morphological operation. rtuonline.com [16]

OR

Q.4 Explain following: - [10]

(a) Convex Hull

(b) Thickening

(c) Skeletons

(d) Pruning

UNIT – V

Q.5 Discuss fundamentals of digital image compression and scaling methodologies. [16]

OR

Q.5 Explain the fundamental of edge – based segmentation. [16]

Mapping Justification

CO	PO	Justification
CO1, CO2, CO3, CO4, CO5	PO1	To Implement design any Linear time invariant system student required the basic knowledge of mathematical equation of discrete time signal like unit impulse and unit step signal that's why CO1,CO2,CO3 are highly mapped with PO1 and CO5 is mapped with PO1 at low level .
	PO2	To analysis of image parameter such intensity level, noise students have of basic knowledge of mathematical formula and algorithm that's why CO1, CO2, CO3 are moderately mapped with PO2 and CO4, CO5 are mapped with PO2 at low level.
	PO3	To Design and development of IIR and FIR filter student have a knowledge of Chebyshev approximation and Butter Worth approximation that's why CO2, CO3 are highly mapped with PO3, CO5 is moderately mapped with PO3 and CO1, CO2 are mapped with PO3 at low level.
	PO4	To implement reconfigurable LTI system & different Image processing algorithm student required to conduct investigation of complex problem using DSK 6713 & DSK 6416 DSP Processor that's why CO2,CO3 are highly mapped with PO4 and CO1 & CO5 map with PO4 at low level.
	PO5	To evaluate noise and signal power reconfigurable LTI system & in different Image processing algorithm student required to knowledge of modern tool code composer studio and DSK 6713 & DSK 6416 DSP Processor that's why CO2,CO3 & CO5 are highly mapped with PO5 and CO4 moderate map with PO5.
	PO8	To Design and development of IIR and FIR filter and use to rectify enviourmental noise due to fog and dust student have a knowledge of Chebyshev approximation and Butter Worth approximation that's why CO3 is moderately mapped with PO8.