SEMESTER S6

DIGITAL IMAGE PROCESSING

Course Code	**PEAET635**	**CIE Marks**	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	**ESE Marks**	60
Credits	5/3	**Exam Hours**	2 Hrs. 30 Min.
Prerequisites (if any)	PBECT504 Digital Signal Processing	**Course Type**	Theory

Course Objectives:

1. To establish a theoretical foundation for fundamental concepts in Digital Image Processing
2. Comprehend the algorithms utilized in two-dimensional signal processing.
3. Apply image processing techniques to address engineering challenges.

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SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	**Digital Image Fundamentals -** Image representation, basic relationship between pixels, elements of DIP system, elements of visual perception- simple image formation model. Digital Camera working principles Brightness, Contrast, Hue, Saturation. Colour image fundamentals - RGB, CMY, HIS models, 2D sampling, Quantization. Review of matrix theory - Row and column ordering - Toeplitz, Circulant and block matrix.	9
2	**2D Image transforms -** DFT and its properties, DCT, KL transform and Singular Value Decomposition. Image Enhancement - Spatial domain methods - point processing- intensity transformations, histogram processing, image subtraction, image averaging.	9

	Spatial filtering- smoothing filters, sharpening filters. Frequency domain methods - low pass filtering and high pass filtering.	
3	**Image Restoration** - Degradation model, Unconstrained restoration-Lagrange multiplier and constraint restoration Inverse filtering - removal of blur caused by uniform linear motion. Feature Extraction - Introduction to feature extraction techniques-Harris corner detection, SIFT	**9**
4	Feature descriptors - Histogram of Oriented Gradients (HOG), Scale Invariant Features Image Classification - Support Vector Machine, Decision Trees, Object Detection using **HOG, Object Detection using Viola-Jones Algorithm.** Image Segmentation - Thresholding, Region-based segmentation, Clustering techniques (k-means). Morphological Operations - Dilation and Erosion, Opening and Closing, Hit-or-Miss transformation, Boundary Extraction, Region filling,	**9**

Course Assessment Method
(CIE: 40 marks, ESE: 60 marks)

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Continuous Internal Evaluation Marks (CIE):

Attendance	*Internal Ex*	*Evaluate*	*Analyse*	*Total*
5	**15**	**10**	**10**	**40**

Criteria for Evaluation (Evaluate and Analyse): 20 marks

- Each student should design, implement, and analyze a digital image processing system for various applications.
- System development can be accomplished using
  - Python: OpenCV, NumPy, Scikit-image
  - MATLAB: Image Processing Toolbox
- **Each student should do minimum two microprojects from each of the below Topics 1 to 5. Topic 6 is not compulsory.**
  - **Topic 1: Basic Image Manipulation**
    - Grayscale Conversion: Convert color images to grayscale.
    - Image Resizing: Implement different resizing techniques (nearest neighbor,

bilinear, bicubic).

- Image Cropping: Allow users to crop specific regions of an image.
- Image Rotation: Rotate images by specified angles.
- Image Flipping: Flip images horizontally or vertically.

- **Topic 2: Image Enhancement**
  - Contrast Adjustment: Adjust image contrast using linear or non-linear methods.
  - Brightness Adjustment: Modify image brightness.
  - Histogram Equalization: Enhance image contrast using histogram equalization.
  - Image Sharpening: Apply sharpening filters to enhance image details.
- **Topic 3: Image Filtering**
  - Averaging Filter: Apply a smoothing filter to reduce noise.
  - Median Filter: Remove noise while preserving edges.
  - Gaussian Blur: Create a Gaussian blur effect.
  - Edge Detection: Implement edge detection techniques (Sobel, Canny).
- **Topic 4: Image Analysis**
  - Image Segmentation: Divide an image into meaningful regions.
  - Object Detection: Detect specific objects within an image.
  - Feature Extraction: Extract relevant features from images
- **Topic 5: Image Classification**
  - Traffic Sign Recognition: Classify common traffic signs (stop, yield, speed limit, etc.).
  - Cat vs. Dog Classification: Build a model to differentiate between cat and dog images.
  - Classify fruits (apples, oranges, bananas).
- **Topic 6 (optional): Advanced Image Classification with Machine Learning**
  - Recognize different types of flowers.
  - Classify types of cars (sedan, SUV, truck).
  - Detect objects in images (faces, cars, pedestrians).

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The project deliverables consist of the following components:

- Detailed design specifications
- Identification and resolution of technical challenges
- Designed and developed algorithms
- Implementation results and performance evaluations

- Comprehensive project report, incorporating methodology, results, challenges, and recommendations.

End Semester Examination Marks (ESE):

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
• 2 Questions from each module. • Total of 8 Questions, each carrying 3 marks **(8x3 =24marks)**	• 2 questions will be given from each module, out of which 1 question should be answered. • Each question can have a maximum of 3 sub divisions. • Each question carries 9 marks. **(4x9 = 36 marks)**	**60**

Course Outcomes (COs)

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At the end of the course students should be able to:

	Course Outcome	Bloom's Knowledge Level (KL)
CO1	Identify and summarize the aspects of digital image processing.	**K2**
CO2	Demonstrate knowledge of the significance of transforms in digital image processing.	**K2**
CO3	Apply principles and techniques of image restoration, enhancement, and segmentation.	**K2**
CO4	Utilize modern principles and techniques for classifying and segmenting images.	**K3**
CO5	Model and solve engineering problems by utilizing digital image processing algorithms.	**K5**

Note*: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create*

CO-PO Mapping Table (Mapping of Course Outcomes to Program Outcomes)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	2	2								3
CO2	3	2	2	2								3
CO3	3	2	2	2	2							3
CO4	3	2	2	2	2							3
CO5	3	2	3	2	2	2	2	2			3	3

Note: *1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation*

Text Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Digital Image Processing	Gonzalez Rafel C	Pearson Education	1/e, 2009
2	Fundamentals of digital image processing	Jain Anil K	Prentice Hall	1/e, 1989
3	Foundations of Computer Vision	Antonio Torralba	MIT Press	1/e, 2024
4	Computer Vision: Algorithms and Applications	Richard Szeliski,	Springer	2/e, 2010

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Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Digital image processing	Kenneth R Castleman	Pearson Education	2/e, 2003
2	Digital image processing	Pratt William K	John Wiley	4/e, 2007
3	Hands-On Image Processing with Python	Sandipan Dey	Packt Publishing	1/e, 2024
4	Computer Vision with Python 3	Saurabh Kapur	Packt Publishing	1/e, 2017
5	Programming Computer Vision with Python	Jan Erik Solem	O'Reilly Media	1/e, 2012

Video Links (NPTEL, SWAYAM…)	
Module No.	**Link ID**
1	https://www.youtube.com/playlist?list=PL1F076D1A98071E24
2	https://www.youtube.com/playlist?list=PL1F076D1A98071E24
3	https://www.youtube.com/playlist?list=PL1F076D1A98071E24
4	https://www.youtube.com/playlist?list=PL1F076D1A98071E24 https://www.youtube.com/playlist?list=PLwdnzlV3ogoVsma5GmBSsgJM6gHv1QoAo

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