Name:

Enrolment No:

UPES

End Semester Examination, May 2025

Program Name: M. Tech Robotics Engineering — **Semester: II**

Course Name: Digital Signal and Image Processing — **Time: 3 Hrs**

Course Code: ECEG-7033 — **Max. Marks: 100**

Nos. of page(s): 2

Instructions: Assume any data in the design, if required.

SECTION-A (5Q x 4M = 20 Marks)

S.No.		Marks	CO
Q.1	What is the significance of the signal quantization and encoding? Show how it can be used to process with the fixed word length for the sampled data.	**4**	**CO1**
Q.2	What is the concept of image negatives and thresholding in image processing segmentation? Explain	**4**	**CO2**
Q.3	Write the MATLAB code for the addition, subtraction, multiplication, and division arithmetic operations of the images.	**4**	**CO3**
Q.4	Differentiate Energy and Power signals with examples and mathematical proof.	**4**	**CO1**
Q.5	Derive the mathematical equation of the single-layer perceptron ANN model and detail its functionality.	**4**	**CO4**

SECTION B (4Q x 10M = 40 Marks)

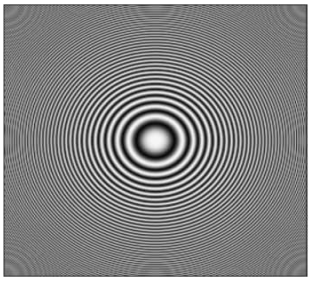
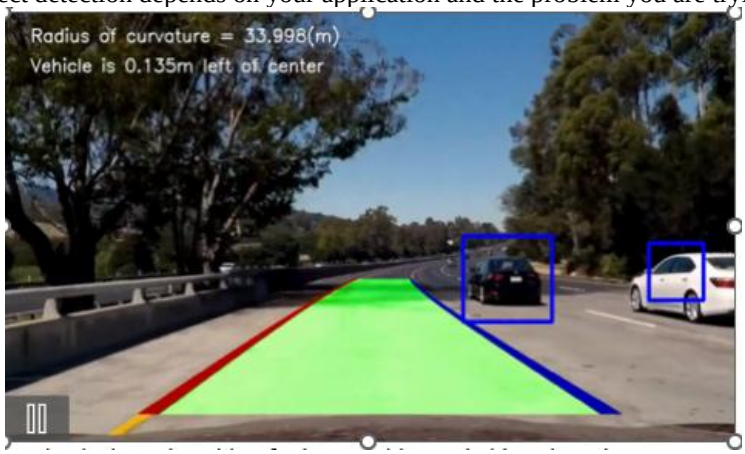
Attempt all the following

Q.6	Demonstrate that the 3×3 mean filter operates as a low-pass filter in the frequency domain, and analyze the corresponding mathematical expressions to support this behavior. Derive the mathematical equation for the same.	**10**	**CO2**
Q.7	Provide a detailed explanation and a pictorial representation of the bit plane slicing concept, along with MATLAB or Python code to demonstrate its functionality.	**10**	**CO3**
Q.8	Detail the significance of Sobel, Prewitt, and Schaar operators and their mathematical operations. ***OR*** Show the mathematical equations for the state space representation of the Continuous-time LTI system	**10**	**CO3**
Q.9	**(a)** Perform the histogram equalization of the image and plot the histogram. $\begin{bmatrix} 4 & 4 & 4 & 4 & 4 \\ 3 & 4 & 5 & 4 & 3 \\ 3 & 5 & 5 & 5 & 3 \\ 3 & 4 & 5 & 4 & 3 \\ 4 & 4 & 4 & 4 & 4 \end{bmatrix}$ **(b)** How sampling theorem is used to convert the continuous signal into discrete. Explain the complete process with proof and mathematical equations.	**5+5**	**CO2**

SECTION-C (2Q x 20M = 40 Marks)

Attempt any *two* of the following

Q.10	**(a)** Consider a case of the multicluster image processing system (8 x 8). Explain the optimal routing scheme with the mathematical calculations about maximum availability and links. **(b)** Explain the role of the median filter in image processing and derive the mathematical expression for its behavior as a low-pass filter. Compute the value of the marked pixels shown in the (3 x 3) mask.	**10+10**	**CO3**

	$\begin{bmatrix} 18 & 22 & 33 & 25 & 32 & 24 \\ 34 & 128 & 24 & 172 & 26 & 23 \\ 22 & 19 & 32 & 31 & 28 & 26 \end{bmatrix}$		
Q.11	**(a)** Detail the wavelet decomposition technique and mathematical equations using the HAAR wavelet. Consider 256 x 256 DWT and decompose the image shown in Fig.1 to 2nd level.  Fig.1 **(b)** Write the significance of region splitting in image processing. Apply the region splitting and merging technique for the image given below. Draw the quadtree for (8 x 8), 2D image. Explain the detailed operation to support your answer.  Fig.2	**10+10**	**CO4**
Q.12	Object detection is a computer vision technique for locating instances of objects in images or videos. Object detection algorithms typically leverage machine learning or deep learning to produce meaningful results. When looking at images or videos, humans can recognize and locate objects of interest in a matter of moments. The goal of object detection is to replicate this intelligence using a computer. The best approach for object detection depends on your application and the problem you are trying to solve.  Fig.3 **(a)** Suggest what can be the best algorithm for lane tracking and object (car) detection as depicted in Fig.3. **(b)** Apply the same algorithm or hybrid algorithm for the detection of cars ((Haar, Randon, Walsh, Hadamard). Write Mathematical equations, methods, and flow chart for the same.	**10+10**	**CO2**