MANGALORE INSTITUTE OF TECHNOLOGY & ENGINEERING
(A Unit of Rajalaxmi Education Trust®, Mangalore)
Autonomous Institute affiliated to VTU, Belagavi, Approved by AICTE, New Delhi
Accredited by NAAC with A+ Grade & ISO 9001:2015 Certified Institution

Model Question Paper

Fourth Semester MCA Degree Examination

Computer Vision

Time: 3 Hours **Max. Marks: 100**

***Note:** 1. Answer any FIVE full questions, choosing ONE full question from each module.*
2. M: Marks, L: RBT (Revised Bloom's Taxonomy) level, C: Course outcomes.

Module -1			**M**	**L**	**C**
Q1	a.	A 3D point P(2,3,5) is: Rotated 90° counterclockwise about the Z-axis. Translated by (+4,−2,+1). Projected onto the XY-plane using orthographic projection. Perform the transformations in sequence and calculate the final projected coordinates.	10	L3	CO1
	b.	A camera has radial lens distortion modeled by: $x_{corrected} = x(1 + k_1 r^2), \quad y_{corrected} = y(1 + k_1 r^2)$ where $r^2 = x^2 + y^2$, $k_1 = 0.002$. If a pixel's normalized coordinates are (0.4,0.3), calculate the corrected coordinates after distortion correction.	10	L3	CO1
OR					
Q2	a.	A periodic pattern has a spatial frequency of 8 cycles/mm. A camera sensor has a pixel pitch of 0.05 mm. Calculate the sampling frequency in cycles/mm. Determine if aliasing will occur using the Nyquist theorem. If aliasing occurs, calculate the aliased frequency.	10	L3	CO1
	b.	A Lambertian surface has an albedo $, \rho = 0.7$ and is illuminated by a directional light with intensity I=150 units. The angle between the surface normal and light direction is 45∘. Using $I_r = \rho \cdot I \cdot \cos(\theta)$ calculate the reflected intensity from the surface	10	L3	CO1
Module 2					

			Marks	Level	CO
Q3	a.	An image has the following gray levels and their probabilities: Gray Level rk — Probability p(rk) 0 — 0.10 1 — 0.20 2 — 0.40 3 — 0.30 Perform histogram equalization and find the new gray levels after transformation. Show all steps.	10	L3	CO2
	b.	A pixel in RGB format has values R=100, G=150, B=200. Convert it into grayscale intensity using the formula: $I = 0.299R + 0.587G + 0.114B$ Then, apply a contrast stretching transform to map the intensity range [50, 200] to [0, 255]. Show all calculations.	10	L3	CO2
OR					
Q4	a.	Linear Filtering – Separable Filter Application . You are given a 3×3 image patch: $\begin{bmatrix} 10 & 20 & 30 \\ 40 & 50 & 60 \\ 70 & 80 & 90 \end{bmatrix}$ and a separable filter defined as: Row filter: $\frac{1}{3}[1\ 1\ 1]$ Column filter: $\frac{1}{3}[1\ 1\ 1]^T$ Perform the filtering operation step-by-step and compute the resulting central pixel value.	10	L3	CO2
	b.	A 1D signal $f(x) = [4, 0, 2, 0]$ is given. Compute its Discrete Fourier Transform (DFT). Apply an ideal low-pass filter that keeps only the lowest 2 frequency components and sets the rest to zero. Compute the inverse DFT to get the filtered signal.	10	L3	CO2
Module – 3					
Q5	a.	Two feature points are detected in image A: $P_1(4, 7)$, $P_2(6, 5)$ and their possible matches in image B: $Q_1(5, 8)$, $Q_2(8, 6)$. Using Euclidean distance, calculate which point in image B matches best with each point in image A. Show all calculations.	10	L3	CO3
	b.	Given the following image patch (pixel intensities):	10	L3	CO3

		$\begin{bmatrix}100 & 102 & 104\\98 & 100 & 102\\96 & 98 & 100\end{bmatrix}$ Apply the Sobel operator with Gx= $\begin{bmatrix}-1 & 0 & 1\\-2 & 0 & 2\\-1 & 0 & 1\end{bmatrix}$ and $G_y = \begin{bmatrix}-1 & -2 & -1\\0 & 0 & 0\\1 & 2 & 1\end{bmatrix}$ to find the gradient magnitude at the center pixel.			
OR					
Q6	a.	In the Hough transform, a line is detected at parameters: ρ=10,θ=45∘ Write the equation of the line in the form y=mx+c. Show step-by-step derivation from Hough parameters to slope–intercept form.	10	L3	CO3
	b.	Two lines in an image are given by: Line 1: $y = 2x + 3$ Line 2: $y = -x + 9$ Find the vanishing point (intersection point) of these lines by solving the equations. Show all steps.	10	L3	CO3
Module – 4					
Q7	a.	Two-Frame Structure from Motion – Triangulation Two calibrated cameras observe the same 3D point. • Camera 1 center: C1=(0,0,0), focal length = 1.0 • Camera 2 center: C2=(1,0,0), focal length = 1.0 • Image coordinates in Camera 1: (u1,v1)=(0.2,0.3) • Image coordinates in Camera 2: (u2,v2)=(−0.1,0.25) Using triangulation, compute the 3D coordinates of the point. Show all steps	10	L3	CO4
	b.	You are given the following measurement matrix W for 3D points across 2 frames (values are in pixels): $W = \begin{bmatrix}1.0 & 2.0 & 3.0\\1.5 & 2.5 & 3.5\\0.5 & 1.0 & 1.5\\0.7 & 1.2 & 1.7\end{bmatrix}$ Using the Tomasi–Kanade factorization method, compute the rank-3 approximation of W (show SVD steps).	10	L3	CO4
OR					
Q8	a.	Given two 1D image patches: Frame 1: [100,102,105,110] Frame 2: [102,105,110,115] Estimate the **translation t** between Frame 1 and Frame 2 by minimizing the **sum of squared differences (SSD)** for integer shifts.	10	L3	CO4
	b.	An affine motion model is given by: $\begin{cases} x' = a_1 x + a_2 y + a_3 \\ y' = a_4 x + a_5 y + a_6 \end{cases}$	10	L3	CO4

		From the following correspondences: x,y → x′,y′ (1, 2) (2, 4) (2, 1) (3, 3) (3, 2) (4, 5) Formulate the equations and solve for the affine parameters a1,a2,…,.a6.			
Module – 5					
Q9	a.	Face Recognition – Eigenfaces Projection You are given an average face vector: An $\mu = [100, 120, 90]$ $e = [0.5, -0.5, 0.7]$ eigenface vector: and a new face image vector: • Step 1: Subtract the mean face (μ) from the new face vector (x). • Step 2: Project the result onto the eigenface vector e to get the weight w. Show all calculations.	10	L3	CO5
	b.	Two sets of matched feature points (before alignment) are: Image A: (10, 20), (15, 25), (20, 30) Image B: (12, 22), (17, 26), (22, 32) Using Euclidean distance, calculate the average alignment error between the two sets of points.	10	L3	CO5
OR					
Q10	a.	A visual vocabulary of size 4 is used: $\{V_1, V_2, V_3, V_4\}$. A test image's local features are assigned to visual words in the order: $V_2, V_2, V_1, V_4, V_2, V_3, V_1$. • Create the normalized histogram (each bin divided by total count). • Show your calculation step-by-step.	10	L3	CO5
	b.	An object recognition algorithm is tested on 5 segmented regions in an image. The ground truth labels are: Cat, Dog, Dog, Cat, Bird The predicted labels are: Cat, Dog, Cat, Cat, Bird • Compute the recognition accuracy (%) considering segmentation results.	10	L3	CO5