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

Third 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.

<table>
<tr><th colspan="3">Module -1</th><th>M</th><th>L</th><th>C</th></tr>
<tr><td rowspan="2">Q1</td><td>a.</td><td>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.</td><td>10</td><td>L3</td><td>CO1</td></tr>
<tr><td>b.</td><td>Given a pinhole camera model with focal length f=50f = 50f=50 mm and a 3D point (X=100, Y=50, Z=500),
Compute the projected 2D image coordinates.</td><td>10</td><td>L3</td><td>CO1</td></tr>
<tr><td colspan="6">OR</td></tr>
<tr><td rowspan="2">Q2</td><td>a.</td><td>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.</td><td>10</td><td>L3</td><td>CO1</td></tr>
<tr><td>b.</td><td>A smartphone camera captures images, processes color, compresses data, and stores photos.
Apply digital camera pipeline and explain how the following work together:

• Image formation
• Sampling
• Color processing
• Compression</td><td>10</td><td>L3</td><td>CO1</td></tr>
<tr><td colspan="6">Module 2</td></tr>
<tr><td>Q3</td><td>a.</td><td>An image has the following gray levels and their probabilities:

Gray Level rk   Probability p(rk)
0   0.10
1   0.20</td><td>10</td><td>L3</td><td>CO2</td></tr>
</table>

		2 0.40 3 0.30 Perform histogram equalization and find the new gray levels after transformation. Show all steps.			
	b.	A pixel in RGB format has values R=100, G=150, B=200. Convert it into gray-scale intensity using the formula: $I = 0.299R + 0.587G + 0.114B$ Apply a contrast stretching transform to map the intensity range [50, 200] to [0, 255]. Show all the calculations.	10	L3	CO2
OR					
Q4	a.	A point (3,4) is scaled by a factor of 2 and rotated by 90°. Apply transformation techniques and compute the new coordinates.	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): $\begin{bmatrix} 100 & 102 & 104 \\ 98 & 100 & 102 \\ 96 & 98 & 100 \end{bmatrix}$ 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.	10	L3	CO3
OR					
Q6	a.	In the Hough transform, a line is detected at parameters: $\rho=10, \theta=45^\circ$ 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	10	L3	CO3

		equations. Show all steps.			
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: $$\begin{cases} x' = a_1 x + a_2 y + a_3 \\ y' = a_4 x + a_5 y + a_6 \end{cases}$$ 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.	10	L3	CO4
Module – 5					
Q9	a.	Face Recognition – Eigenfaces Projection You are given an average face vector: $\mu = [100, 120, 90]$ $e = [0.5, -0.5, 0.7]$ An 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