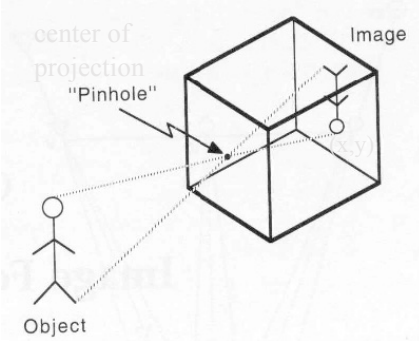
DSE312-Computer Vision Final Exam(100 marks)

Q1.

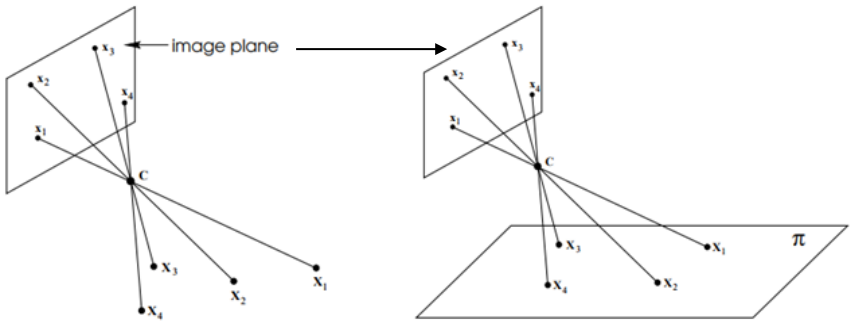
a. A point x is translated to a new point x' by (a,b) and then then point x' undergoes pure rotation by an angle θ which is assigned a new point x''. Considering x, x',x'' as 2D points in the Euclidean space, write the transformation matrices from x to x''.

b. The new coordinates of x'' after transformation are non-integer values. Are these valid? Explain. (5)

Q2. The pinhole camera model is used as shown below, however the output image is considerably blurred. What step(s) can be undertaken to reduce the blurring effect. (2)



Q3. In image formation, the camera projection centre c, the image planes and the location of points are shown for 2 cases. Suppose the camera centre (c) is translated by y amount, can the new image planes (for the 2cases) be related to the existing image plane using projective transformation. Explain.



(5)

Q4. Within 100 words (use figures if need be), explain the steps involved in transforming a 3D world point to 2D image plane. Under what condition can this approach fail?
(8)

Q5. The same image is given to Person A and Person B.
Person A applies kernel w1 to the image, and then kernel w2 to the image.
Person B on the other hand, convolves kernels w1 & w2 to form a new kernel w and then applies kernel w to the image.
How will the output images be for the two of them, explain.
(3)

Q6. For a special case of perspective projection, the distance from the projection centre to the image plane is infinite, what happens to parallel lines in this case. What will be the matrix equation?
(3)

Q7. An image of a circle is taken at different lighting conditions, which results in different average intensities as shown below. Explain what method would you use to detect the circle for these cases and why?Note: you don't have to implement, simply describe your strategy.
(4)


Average pixel intensity: 28.29


Average pixel intensity: 39.62


Average pixel intensity: 45.57


Average pixel intensity: 55.95

Q8. In perspective projection geometry, you are given point x1, x2 that lies on a line l , in what ways can x1, x2 and l be related mathematically?
(3)

Q9. A 3X3 kernel is shown below. When applying a Gaussian smoothing operation, how could the values be ordered to obtain optimal result? Explain

H(0,0)	H(1,0)	H(2,0)
H(0,1)	H(1,1)	H(2,1)
H(0,2)	H(1,2)	H(2,2)

i. H(1,1)>H(0,1) , H(2,1)> H(0,0)

ii. H(1,0)>H(1,1), H(1,2)> H(1,1)

iii. H(0,0) > H(1,0), H(1,0) > H(2,0)

iv. H(1,1)>H(1,0), H(1,1) > H(1,2)

v. H(1,2)> H(0,2), H(1,0)>H(2,2)

If the same kernel is used for image sharpening, what would be the optimal?

i. H(1,1)>H(1,0), H(1,1) > H(1,2)

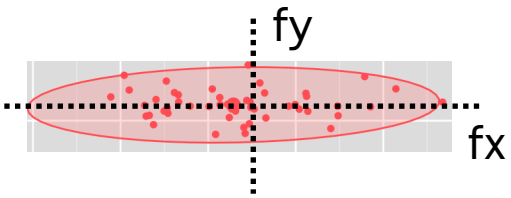
ii. H(1,0)>H(1,1), H(1,2)> H(1,1)

iii. H(0,0) > H(1,1), H(2,2) > H(1,1)

iv. H(1,1)>H(0,1) , H(2,1)> H(0,0)

v. H(1,2)> H(0,2), H(1,0)>H(2,2)
(4)

Q10. The spread of (fx,fy) of the structure matrix is depicted as following, which feature would this be able to detect within an image? Write the matrix and explain. (2)

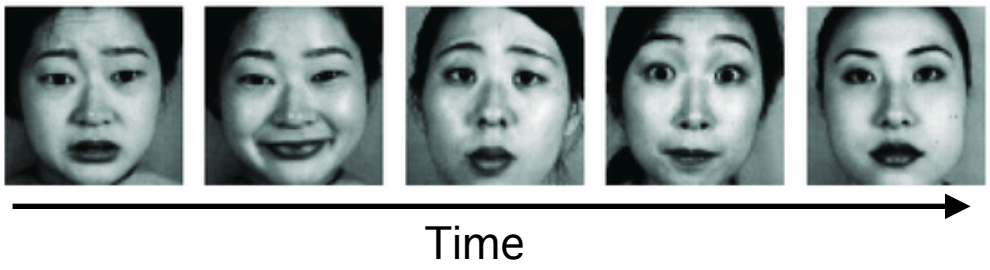


Q11. Given is the gradient direction of 168° and magnitude of 165. How will the HoG feature vector be computed for this value? Show the steps. (3)

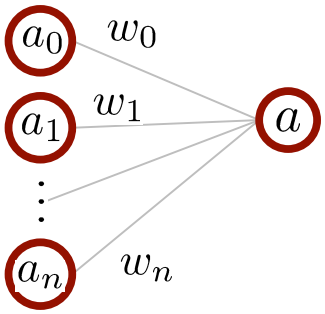
Q12. For the following region shown below, compute the integral image, and write at least one advantage of integral images. (3)

9	10	9	4	3
5	7	8	9	3
4	5	**6**	8	5
3	4	5	6	8
2	3	4	5	6

Q13. The following set of facial expressions across consecutive time frames are given for a person, is it possible to devise an efficient method that automatically captures the facial expressions? What will be the steps. (5)



Q14. You have been given a sigmoid activation function, with large weights on each neuron, what possibly will be the output at the neuron 'a'? Show the workings and provide your comments. (4)



Q15. For the following projection matrix, compute the intrinsic parameter and the centre of projection

$$\begin{pmatrix} 0.7679 & -0.4938 & -0.0234 & 0.0067 \\ -0.0852 & -0.0915 & -0.9065 & -0.0878 \\ 0.1827 & 0.2988 & -0.0742 & 1.0000 \end{pmatrix}$$

(6)

Q16. Given a set of 4 point pairs, compute the homography matrix. Explain in your own words what a homography represents and why at least 4 point pairs are required. (8)

$$\begin{aligned} (x_i', y_i') &\leftrightarrow (x_i, y_i) \\ (5,4) &\leftrightarrow (0,0) \\ (7,4) &\leftrightarrow (1,0) \\ (7,5) &\leftrightarrow (1,1) \\ (6,6) &\leftrightarrow (0,1) \end{aligned}$$

Q17. Given are the coordinates of corresponding points in pixels, compute the Fundamental matrix. Explain briefly what does the Fundamental matrix encode. And how it relates to epipolar geometry. (10)

i	x_i'	y_i'	x_i''	y_i''
1	533.4	140.2	650.6	524.9
2	1047.3	570.0	1008.2	795.4
3	2033.0	491.8	1849.7	1080.9
4	139.7	1639.8	235.9	1730.0
5	1555.2	2021.5	1510.1	2012.5
6	927.1	2869.0	933.1	2784.9
7	557.5	3346.8	671.7	3169.5
8	1991.0	3184.6	1858.7	2938.1

Q18. Given Fundamental Matrix, F: F=[-0.00310695 -0.0025646 2.96584;
-0.028094 -0.00771621 56.3813;
13.1905 -29.2007 -9999.79];
Ensure the matrix rank is correct else take necessary steps and compute the epipolar line, given point on image1 x=[343.53;221.70;1.0];
Describe where this line will lie and very briefly the geometrical constraints.
Compute the epipole of F? (10)

Q19. Given the baboon image, apply a denonising filter and implement the Harris corner, display the corners using figure. Ensure that invalid points are removed. Write the structure matrix and explain the steps briefly in your own words with supporting equations.
(5)

Q20.You want to design a 2D-elliptical Gaussian filter kernel to smooth an image, such that you have more smoothing in the horizontal than the vertical. Express in terms of the parameters to obtain such a filter.
(2)

Q21. In the given binary image (binaryshapes.png), compute the bounding box, and centroid of each object and show the results as a figure.
(5)