All documents are allowed. The different sections below are independent. Answers should be **concise** *and* **justified**.

1 Computer Vision (4 points)

1. The plenoptic function: describe the input parameters involved and what is its output. Choose two parameters and describe what do you learn about the scene if you change the input and find a magnitude change in the output.
2. What are the desirable characteristics of any computer vision solution? Describe them. For each one give an application example where it is critical, and an application where the characteristic is not critical.
3. What is a Bayer filter? Explain the motivation to use it and its consequences.
4. You have an image of two cars in a garage. They both appear black in the image. The garage is lid with a monochromatic blue light. What can you say about the car colors?

2 Hough Transform (4 points)

1. (1 pt) Recall the principle and algorithm of the Hough transform applied to interest points detected in an image.
2. (3 pt) The goal now is to detect circles in an image. Propose a parametrization of the circle allowing to adapt the Hough algorithm. Precisely detail which parameters you would use, which operations would be computed for each interest point, and the final criterion to identify a circle and its parameters.

3 Image Mosaics (4 points)

Assume that a camera acquires images while rotating about its optical center and assume further that the intrinsic parameter matrix K is the identity matrix.

1. Is the transformation between 2 such images projective or affine ?
2. How many pairs of corresponding points are required to estimate this transformation ?
3. We want to build a cylindrical panorama using several images of that camera, detail the different steps of an algorithm for doing so.

4 Geometry (4 points)

1. Assume that C is the centroid of a set of n points $\{P_i\}_{i\in[1..n]}$ in the affine space $\mathcal{A}^2$, i.e. C is the mean position of $\{P_i\}_{i\in[1..n]}$. Is this centroid preserved by an affine transformation of the plane ? by a projective transformation of the plane ?

2. q1 and q2 are two image observations of a 3D point Q. Due to the noise, these points do not correspond to the exact projection of Q. As a result, the viewing lines of q1 and q2 do not intersect in 3D.

   (a) A good geometric approximation for Q is the point closest to both viewing lines. How can we estimate that approximation ?

   (b) Is there a closed form solution for it ?

5 Shape Modeling (4 points)

1. What solutions can we use to observe shape models in 3D without wearing specific devices such as glasses or head mounted displays ?

2. Can we replace an explicit 3D models, e.g. a mesh, with an implicit representation, e.g. an implicit occupancy function in 3D ? how ? and what would be the interest of doing so ?