

## Computer Graphics – DCC – FCUP

The aim of this worksheet is to guide you through your learning process. Use it as a reference to help you solve the course assignments.

### Worksheet: OBJ format and Transformations

Book Reference: Essential Mathematics for Games & Interactive Applications (by James M. Van Verth and Lars M. Bishop, second edition) Chapter 4.

*The format of an OBJ file (there are other possible variations)*

```
# List of Vertices, with (x,y,z) coordinates.
v 0.123 0.234 0.345
v ...
...
# Texture coordinates, in (u ,v) coordinates, these will vary
between 0 and 1.
vt 0.500 1    vt ...
...
# Normals in (x,y,z) form; normals might not be unit.
vn 0.707 0.000 0.707
vn ...
...
# Face Definitions
f 6/4/1 3/5/3 7/6/5
f ...
```

Now that you know how to read a 3D object you will need to learn to manipulate the object in a 3D space. To do so an alternative is to apply Geometric Transformations.

### *2D Homogeneous Transformations*

**scale**

$$\mathbf{M}_{3 \times 3} = \begin{pmatrix} s_x & 0 & 0 \\ 0 & s_y & 0 \\ 0 & 0 & 1 \end{pmatrix}$$

**rotate**

$$\mathbf{M}_{3 \times 3} = \begin{pmatrix} \cos \alpha & -\sin \alpha & 0 \\ \sin \alpha & \cos \alpha & 0 \\ 0 & 0 & 1 \end{pmatrix}$$

**translate**

$$\mathbf{M}_{3 \times 3} = \begin{pmatrix} 1 & 0 & t_x \\ 0 & 1 & t_y \\ 0 & 0 & 1 \end{pmatrix}$$

## **1. Understanding how to process an OBJ file**

1.1 Write the data structure to store the values of an OBJ file. The data structure should be organized in such a way that it should allow to later render the OBJ in a 3D Environment

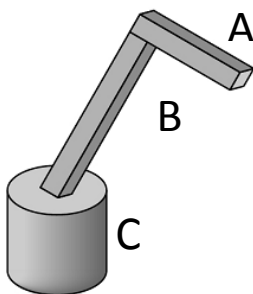
1.2 Write the pseudo-code for rendering an OBJ model (only the rendering stage)

## **2. Transformations**

2.1 What is the difference between a rigid body transformation and a non-rigid body transformation. Explain and sketch.

2.2 Define Linear transformation and Affine transformation.

2.3 Given the arm robot (see figure bellow) write the pseudo-code to manipulate independently each element of the arm (A,B,C). You need to create the functions that will allow scale, translate and rotate. You also need to define the coordinate system.



2.4 Write the 3D homogeneous transformations matrix.