Daily Assignment 19

- This is how ZXZ Euler angles works
  - 1. Rotate along Z-axis by α
  - 2. Rotate along X-axis of the new frame by β
  - 3. Rotate along Z-axis of the new frame by γ

- Start from today's practice code, implement ZXZ Euler angles and add code to change α, β, γ values in the following way:

- If you **press or repeat** a key, the value of α, β, γ should be changed as shown in the table:

  - Hint: You do not need to store a composed rotation matrix as a global variable. You can just store α, β, γ as global variables

Key	Transformation
A	Increase α by 10°
Z	Decrease α by 10°
S	Increase β by 10°
X	Decrease β by 10°
D	Increase γ by 10°
C	Decrease γ by 10°
V	Initialize orientation

```python
gAlpha = 0
gBeta = 0
gGamma = 0

def render(ang):
    global gCamAng, gCamHeight
    global gAlpha, gBeta, gGamma

    # ...

    # solution 1
    alpha = np.radians(gAlpha)
    beta = np.radians(gBeta)
    gamma = np.radians(gGamma)
    M = np.identity(4)
    Rz1 = np.array([[np.cos(alpha), -np.sin(alpha), 0],
                    [np.sin(alpha), np.cos(alpha), 0],
                    [0,0,1]])
    Rx = np.array([[1,0,0],
                   [0, np.cos(beta), -np.sin(beta)],
                   [0, np.sin(beta), np.cos(beta)]])
    Rz2 = np.array([[np.cos(gamma), -np.sin(gamma), 0],
                    [np.sin(gamma), np.cos(gamma), 0],
                    [0,0,1]])
    M[:3,:3] = Rz1 @ Rx @ Rz2
    glMultMatrixf(M.T)

    # # solution 2
    # glRotate(gAlpha, 0,0,1)
    # glRotate(gBeta, 1,0,0)
    # glRotate(gGamma, 0,0,1)

    # ...
```

```python
def key_callback(window, key, scancode,
action, mods):
    global gCamAng, gCamHeight
    global gAlpha, gBeta, gGamma
    if action==glfw.PRESS or
action==glfw.REPEAT:
        if key==glfw.KEY_1:
            gCamAng += np.radians(-10)
        elif key==glfw.KEY_3:
            gCamAng += np.radians(10)
        elif key==glfw.KEY_2:
            gCamHeight += .1
        elif key==glfw.KEY_W:
            gCamHeight += -.1
        elif key==glfw.KEY_A:
            gAlpha += 10
        elif key==glfw.KEY_Z:
            gAlpha -= 10
        elif key==glfw.KEY_S:
            gBeta += 10
        elif key==glfw.KEY_X:
            gBeta -= 10
        elif key==glfw.KEY_D:
            gGamma += 10
        elif key==glfw.KEY_C:
            gGamma -= 10
        elif key==glfw.KEY_V:
            gAlpha = 0
            gBeta = 0
            gGamma = 0
```