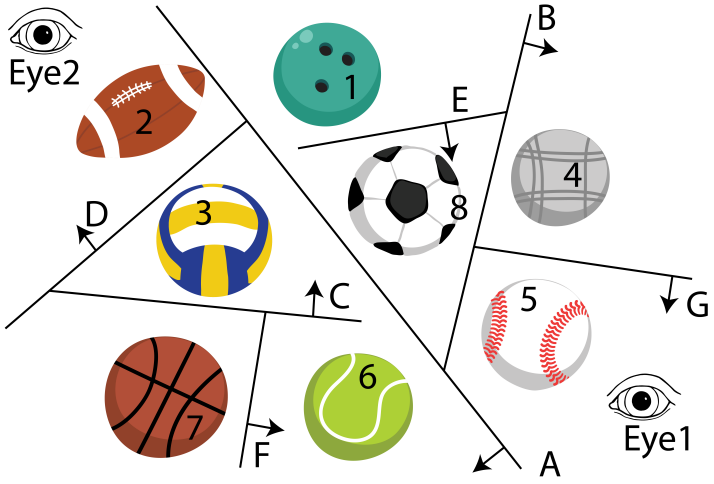
Computer Graphics (COMP3271)
Illumination and Texture

Due Date: 11:59pm, Nov 1, 2019

1. **(20 marks)** Show the difference between perspective projection and orthogonal projection methods by discussing their transformation matrices and rendering results. Also describe how to set up the respective projections using OpenGL.

2. **(20 marks)** Consider a scene with 8 objects (numbered 1 to 8) as shown in the figure below. Construct the corresponding BSP tree. Based on this BSP tree, give the rendering sequence of the objects from the viewpoints Eye1 and Eye2, respectively.

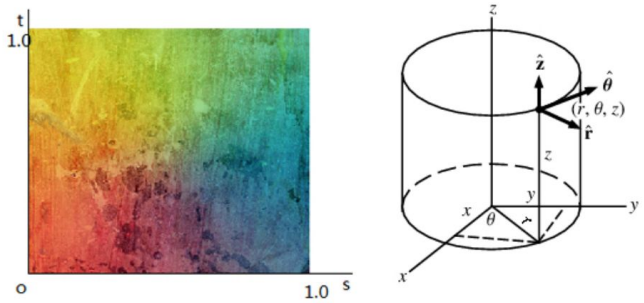


3. **(20 marks)**
   (a) Explain how to detect whether or not a planar boundary face of an object is front-facing.
   (b) Describe the Z-buffer algorithm briefly, and explain how it is used for hidden surface removal.

4. **(20 marks)**
   (a) Describe the three basic components of Phong illumination equation;
   (b) Describe how the Flat shading method and Gouraud shading method work;
   (c) Describe the pros and cons of the Phong shading method.

5. (20 marks)

(a) Consider a texture pattern defined in a unit square $[0, 1]^2$ and a cylindrical surface $\mathcal{S}$, as depicted in the figure below.



(a) (b)

The cylindrical coordinates of a point on $\mathcal{S}$ can be represented as $(r\cos\theta, r\sin\theta, z)$, where r is the radius of the cylindrical surface and $0 \leq \theta \leq 2\pi, 0 \leq z \leq 1$. Suppose we want to wrap the texture on $\mathcal{S}$. Derive a mapping which assigns a texture coorindates in $[0, 1]^2$ to a point on $\mathcal{S}$.

(b) In OpenGL, antialiasing can be controlled by the texture function `glTexParameteri()` with an appropriately chosen minifying or magnification function supplied for the `GL_TEXTURE_MIN_FILTER` or `GL_TEXTURE_MAX_FILTER` texture parameter. Explain the effects of the functions `GL_NEAREST` and `GL_LINEAR` for texture minification or magnification. Which one is more suitable for anti-aliasing?
(Reference page for `glTexParameteri()`: `https://www.khronos.org/registry/OpenGL-Refpages/gl4/html/glTexParameter.xhtml`)