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Geometric Modeling

Assignment sheet 9 (Surface Parametrization/Differential Geometry, due June 24th 2008)

(1) Surface Parametrization [3 points]

Consider the mapping function $f(u, v) = \begin{bmatrix} u \cos(v) \\ u \sin(v) \\ v \end{bmatrix}$ from a 2D domain to a surface.

Find the angle between two intersecting curves $u + v = 0$ and $u - v = 0$ on the surface.

What kind of mapping function does $f(u, v)$ belong to (conformal, equiareal, isometric)?

(2) Principle Curvatures [3 Points]

Show that the principal curvatures of the surface $r(u, v) = \begin{bmatrix} u \cos(v) \\ u \sin(v) \\ e^v \end{bmatrix}$ have opposite signs.

(3) Euler Curvature Formula [4 Points]

Let $k_n(\varphi) = k_{\max} \cos^2(\varphi) + k_{\min} \sin^2(\varphi)$ be the curvature associated with the angle between the current tangent and the tangent of the maximal principal curvature.

Proof that:
$$H = \frac{1}{2\pi} \int_0^{2\pi} k_n(\varphi) d\varphi$$