

# Elementare Differentialgeometrie

## Übungsblatt 5

### Aufgabe 1.

- (a) Sei  $M$  eine Fläche und  $\Pi$  eine Ebene im  $\mathbb{R}^3$ , die  $M$  in einer Kurve  $\gamma$  schneidet. Zeigen Sie, daß  $\gamma$  eine Geodätische ist, falls  $\Pi$  eine Symmetrieebene von  $M$  ist.
- (b) Jede Gerade auf einer Fläche ist eine Geodätische.
- (c) Sei  $M$  die Fläche  $\{x^2 + y^2 - z^2 = 1\}$ . Finden Sie möglichst viele Geodätische auf  $M$ .

**Aufgabe 2.** Man bilde den Durchschnitt des Zylinders  $\{x^2 + y^2 = 1\}$  im  $\mathbb{R}^3$  mit einer Ebene, die die  $x$ -Achse enthält und einen Winkel  $\theta$  mit der  $xy$ -Ebene bildet.

- (a) Zeigen Sie, daß die Schnittkurve  $\gamma$  eine Ellipse ist.
- (b) Berechnen Sie die geodätische Krümmung und die Normalkrümmung von  $\gamma$ , aufgefaßt als Kurve im Zylinder, in den Punkten, in denen die Ellipse ihre Achsen schneidet.

### Aufgabe 3.

- (a) Die Matrix  $(L_{ij})$ , die die zweite Fundamentalförm beschreibt, ist für eine Rotationsfläche wie in Aufgabe 1 vom Übungsblatt 4 gegeben durch

$$\frac{1}{\sqrt{r^2 + z^2}} \begin{pmatrix} rz - zr & 0 \\ 0 & rz \end{pmatrix}.$$

- (b) Es gilt  $\det(L_{ij}) = 0$  genau dann, wenn jeder Meridian eine Gerade ist.

**Aufgabe 4.** Betrachten Sie ein Flächenstück von der Form

$$\kappa(u^1, u^2) = (u^1, u^2, f(u^1, u^2)),$$

d.h. einen Graphen. Berechnen Sie die erste und die zweite Fundamentalförm  $(g_{ij})$ ,  $(L_{ij})$ . Bestimmen Sie das Christoffel-Symbol  $\Gamma_{ij}^k$  sowohl extrinsisch (d.h. mittels der ursprünglichen Definition) als auch intrinsisch (d.h. mittels Satz 3.5).

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