11. Exercises 4 & 11, Section 14.1

12. Exercises 1 & 3, Section 14.2

13. Let \( f(x, y, z) = xyz \), let \( \mathbf{u} \) be the unit vector in the direction from \((1, 2, 3)\) to \((3, 1, 5)\). Find \( \frac{\partial f}{\partial u}(1, -1, 2) \).

14. Define \( S = \{(x, y, z) \mid xy = z\} \).

(a) Let \( p = (a, b, c) \) be a point on \( S \). Find the equation for the tangent plane \( T_p \) to \( S \) at \( p \).

(b) Show that the intersection \( S \cap T_p \) consists of two lines.

15. Let \( a, b \) be real numbers satisfying \( 0 < a < b \). Define a map \( T : \mathbb{R}^2 \rightarrow \mathbb{R}^3 \) by \( T(s, t) = (a \sin s, (b + a \cos s) \sin t, (b + a \cos s) \cos t) \).

Then the image \( \{T(s, t) \mid (s, t) \in \mathbb{R}^2\} \) is a surface in \( \mathbb{R}^3 \) called a torus.

(a) We can define a “height function” \( h(s, t) \) to be the \( z \)-coordinate of the torus. That is, \( h(s, t) = (b + a \cos s) \cos t \). Find the critical points \((s, t)\) of the height function. Show they map to exactly four points \( p \) under \( T \). Show that one such \( p \) is a maximum of \( h \), another is a minimum, and the remaining two are saddle points.

(b) Similarly define a function \( k(s, t) \) to be the \( x \)-coordinate of the torus. Find the critical points \((s, t)\) of this function. To what points \( q \) do these \((s, t)\) map under \( T \)? Which such \( q \) are maxima of \( k \)? Minima? Saddle points?