Question 1. *Is orthogonality reflexive, symmetric, and transitive? If so, it is an equivalence relation. If not true, find a counter-example.*

Solution. The orthogonality is not reflexive: a line cannot be orthogonal to itself (the scalar square of a nonzero vector is nonzero). It is also non-transitive, for example, the line $x = 0$ is orthogonal to $y = 0$, and $y = 0$ is orthogonal to $x = 1$, while $x = 0$ and $x = 1$ are parallel and hence cannot be orthogonal. But the orthogonality is symmetric, because it is fully determined by the scalar product of the direction vectors of the lines, and scalar product is a symmetric function. □