1. Let $R$ be the relation on the set $\mathbb{Z}$ of all integers, where $a R b$ means that $a b \leq 0$. Is $R$ an equivalence relation?
2. Let $\mathbb{R}^{2}$ be the set of all ordered pairs of real numbers; that is, $\mathbb{R}^{2}=\{(x, y): x, y \in \mathbb{R}\}$. Define a relation $R$ on $\mathbb{R}^{2}$, where $\left(x_{1}, y_{1}\right) R\left(x_{2}, y_{2}\right)$ means that $x_{1}+y_{2}=x_{2}+y_{1}$.
(a) Prove that $R$ is an equivalence relation.
(b) Find the equivalence class $[(1,2)]$.
3. Let $R$ be the relation on the set $\mathbb{Z}$ of all integers, where $a R b$ means that $a^{2}=b^{2}$. Determine whether $R$ is reflexive, symmetric, antisymmetric, transitive.
4. Find the matrix that represents the given relations, where the elements are ordered as indicated.
(a) $R$ on $\{1,2,3,4,6,12\}$, where $a R b$ means $a \mid b$.
(b) $R^{2}$, where $R$ is the relation on the set $\{w, x, y, z\}$ given by

$$
R=\{(w, w),(w, x),(x, w),(x, x),(x, z),(y, y),(z, y),(z, z)\}
$$

5. Determine whether the relation on the set $\{a, b, c, d\}$ defined by the matrix $M_{R}$ below (elements are ordered as indicated) is reflexive, symmetric, antisymmetric, transitive.

$$
M_{R}=\left[\begin{array}{llll}
1 & 0 & 1 & 0 \\
1 & 1 & 0 & 1 \\
1 & 1 & 1 & 0 \\
1 & 1 & 0 & 1
\end{array}\right]
$$

6. Draw the Hasse diagram of the relation $R$ on the set $A=\{2,3,4,6,10,12,16\}$, where $(a, b) \in R$ means that $a \mid b$.
7. Find the matrix of the transitive closure of the relation $R$ on the set $\left\{a_{1}, a_{2}, a_{3}\right\}$ whose matrix in the given order is

$$
M_{R}=\left[\begin{array}{lll}
1 & 0 & 1 \\
0 & 1 & 0 \\
0 & 1 & 1
\end{array}\right]
$$

