[1] Find the $3 \times 3$ matrix which maps the vector $(0, 1, 1)$ to $(0, 2, 2)$, and maps each point on the plane $x + y = 0$ to the zero vector.

[2] Find a basis for the row space and a basis for the column space of the matrix

$$
\begin{bmatrix}
1 & 1 & 1 & 0 & 0 & 0 \\
-2 & 0 & 0 & 1 & 1 & 0 \\
0 & -2 & 0 & -1 & 0 & 1 \\
0 & 0 & -2 & 0 & -1 & -1
\end{bmatrix}
$$

[3] Find the $3 \times 3$ matrix that projects orthogonally onto the plane

$$
x + 2y = 0
$$

[4] Find an orthogonal basis for the subspace $V$ of $\mathbb{R}^4$ spanned by the vectors

$$(1, -2, 0, 0) \quad (1, 0, -2, 0) \quad (1, 0, 0, -2) \quad (0, 1, -1, 0) \quad (0, 1, 0, -1) \quad (0, 0, 1, -1)$$

Extend this basis to an orthogonal basis for $\mathbb{R}^4$.

[5] Let $V$ be the vector space of all polynomials of degree $\leq 2$ in the variable $x$ with coefficients in $\mathbb{R}$. Let $W$ be the subspace of $V$ consisting of those polynomials $f(x)$ such that the second derivative $f''(x) = 0$.

Find the orthogonal projection of the polynomial $x^2$ onto the subspace $W$, with respect to the inner product

$$
\langle f, g \rangle = \int_0^1 f(x)g(x) \, dx
$$